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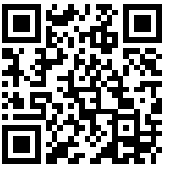

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THE ROYAL ENGINEERS JOURNAL.

Vol. XXXI. No. 1. JANUARY, 1920.

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CHATHAM:
Royal Engineers Institute.
TELEGRAPHIC ADDRESS: SAPPER, CHATHAM. TELEPHONE: CHATHAM, 669.
Agents and Printers: W. & J. Mackay & Co., Ltd.
LONDON:
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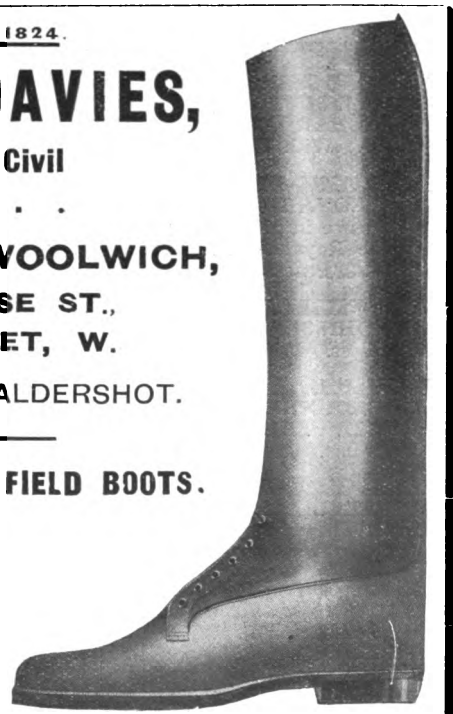

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EARTH-CURRENT TELEGRAPHY.

By CAPT. L. C. CARUS-WILSON, M.C., R.E.

IT has long been known that if a battery is placed in series with an insulated wire earthed at each end, the ground forming the return circuit, the current which flows does not confine itself to the straight line joining the two earths, but spreads out over a large cross section of the ground. Thus in *Fig.* 1, C is a battery connected by two insulated wires to earths A and B. The current flows through the primary circuit BCA and then through the earth from A to B, its passage through the earth covering a wide area as indicated by the lines of flow in the diagram.

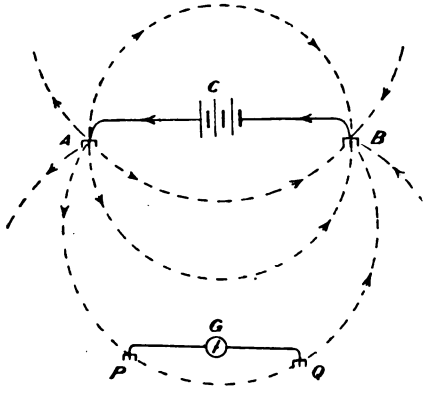

Fig. 1

These lines of flow can be regarded as a number of conductors in parallel, along each of which a fraction of the total current is flowing, and there is therefore a difference of potential between any two points P and Q. Such that if earth connections are made at these points and joined by a secondary insulated wire to a galvanometer a current in the primary circuit will produce a deflection in the galvanometer. The current in the secondary is diminished if these points are moved further away from the primary circuit.

Experiments show that these lines of flow assume definite shapes —approximately arcs of a circle—which are not appreciably affected by irregularities encountered in their course through the ground.

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In order to get the maximum current in the secondary circuit it is necessary for P and Q to be on the same line of flow, and to ensure this, the line joining P and Q must have a definite direction relative to that joining AB.

If a source of alternating current, such as a telephone, be substituted for the battery in the primary, earth currents will be formed in precisely the same way and an alternating current will be produced in the secondary.

Early in the war the principal means of communication at the front was the military telephone, which included, in addition to the usual speaking apparatus, a buzzer for sending messages by the morse code. This instrument is designed on the principle of the trembler bell with a very light armature and a secondary winding having sufficient turns to send a high voltage current into the line.

For reasons of economy earth return circuits were usually employed and the telephone and buzzer messages gave rise to earth currents which strayed great distances from the direct line connecting the two earths. The simplest way to detect such currents was to insert a telephone receiver in a secondary circuit. Signals could then be heard in this receiver whenever messages were being sent through the primary. The power employed, however, was so small, that overhearing with a telephone receiver was only possible from a very short distance, and for satisfactory results a much more sensitive receiver was needed.

In 1915 the French signal engineers found the receiver which was required in the instrument known to us now as the " Low Frequency Amplifier." Its principal feature, namely, the Three-electrode Valve, was based on the familiar " Fleming Valve," but in this case it was used as an amplifier of low frequency currents rather than as a rectifier of high frequency currents. The three-electrode valve is practically a relay for alternating currents. There is no definite make and break of circuits, there are no delicate contacts to adjust and clean, nor is the action of the valve in any way disturbed by external vibration. Since there are no moving parts, there is no mechanical inertia and the current in the local circuit follows every variation of the current in the primary circuit, reproducing exactly, on a magnified scale, any wave form however complicated.

In this amplifier three valves were connected in cascade, the magnified current from the first valve passing through a transformer to the primary circuit of the second valve, and so on. The magnification of each valve, allowing for transformer losses, was five to one, and the total magnification, which rose in geometrical progression with each stage of magnification, was 125 to one. This instrument was suited for connecting on to two earths with a total resistance of between 20 and 100 ohms. This amplifier acted as a receiver and

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it was sufficiently sensitive to enable one to overhear telephone speech from a distance of several thousand yards.

Thus, if we imagine a German field cable near the Front with an earth return circuit and a telephone at each end as shown at A and B in *Fig.* 2, the currents produced by speaking into either telephone would spread out over No Man's Land and into our territory. If two earths are made at E and F and connected to an amplifier at X, everything that is said on the telephone will be heard on the amplifier. These amplifiers were used by the French at various points along the Front. The instrument was installed a few hundred yards from the Front and lines were laid out and earthed at their extremities, as near to the German trenches as possible. The results were very satisfactory and much information was gleaned from the intercepted messages.

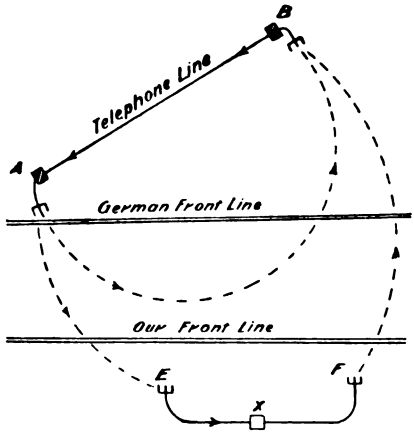

Fig 2

Unfortunately the Germans captured one of these amplifiers; they at once realized its import, and lost no time in producing a similar instrument for intercepting our messages. They were certainly conversant with the valve before the war, but till then evidently it had never occurred to them to use it for this purpose. Before long, however, they had produced a number of amplifiers and organized a thorough system of intercepting our telephone messages.

With one of these instruments most of the communications of one of our divisional fronts could be overheard by the Germans opposite, so that the enemy could obtain with ease, information which was of vital importance to him. Not only was he warned of impending local operations, but he could compile information which led to an accurate knowledge of the *moral* and disposition of our

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forces. On several occasions the Germans were unusually alert at the time of a proposed raid only very shortly after our orders had been issued, or shelled places where working parties were assembling.

Much of the information which was put to the credit of the ubiquitous German spy was undoubtedly attributable to this source. Search was made for spies with concealed wireless apparatus and for lamp signalling stations, but what need had the Germans for complicated methods when they could obtain their information by such a simple means?

It was not until early in 1916 that the British began to make use of the amplifier. The instruments used were chiefly those lent to us by the French, but we had some which were made by the Marconi Company. "Interpreter-Operators" selected for possessing a combined knowledge of the German language and the morse code, were trained in the working of the amplifier and placed at various "Listening Posts" along the line.

There was not much difference between the French methods of working and our own. The amplifier was set up in a dug-out near the Front in a remote spot so as to be away from our own telephones. Five or six earths were made as near to the German trenches as possible. These were connected to a multiple switch at the amplifier by low resistance cables, which were laid far away from our own cables to avoid the interference caused by them.

In order to obtain the maximum current in the amplifier from an enemy telephone it was important that the resistance of the whole circuit, including the amplifier, leads and earths, should be kept low. The main element in this resistance was that of the earth connections. It was impossible to bury large plates or drive iron pipes into the ground within a few yards of the enemy's trenches. If the soil was suitable, fairly good results could be obtained by using a number of small iron earth pins, which could be pushed into the ground. Trials were made connecting the cable with the enemy's barbed wire, but this wire was usually so rusty that it was not electrically continuous and made a high resistance earth.

The resistance of an earth is found almost entirely at the point of contact between the conductor and the earth, so that it was necessary to get the surface of contact as large as possible As we could not secure a large enough metallic surface the next best thing was an electrolytic surface. Using this principle, a good earth was obtained in the following manner:—The end of the wire was bared for about two feet and pushed into a sandbag containing a handful of copper sulphate. It was then tied up at the mouth, taken out to No Man's Land, and dropped into a shell-hole full of water, the wire being unreeled from a drum behind. The crystals dissolved in the water and formed a large conducting surface in contact with the ground, giving an earth resistance of under ten ohms.

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An interesting encounter took place with the Germans on one occasion. It happened that one night one of our earths, A *Fig.* 3, on being tested proved to be broken. The fault was eventually located at the earth itself. We found that our line had been cut off its earth and another line coming from the German trenches had been put in its place, thus connecting our earth A with his earth C. Here was a problem. If we removed the German line and replaced our own the change would certainly be noticed on the German amplifier. If we connected our line on to the German line and disconnected the earth altogether, working through earths B and C, the enemy could pick up as much from us as we could from him. Added to this we knew that the enemy could hear on the amplifier anyone tampering with his line, and might at that moment be lying in wait for us So we decided to leave the line untouched and the next night a pair of lines was run out to the spot, joined carefully on to the bare earth connection about six inches apart, and then the earth connection was cut between our two lines, leaving our earth A and the enemy's line and earth C, connected through on to our amplifier. (See *Fig.* 4). By this means he was not aware that any change had been made, but we had the benefit of his line and earth C inside his lines, while he could hear no more from us than with the original earth.

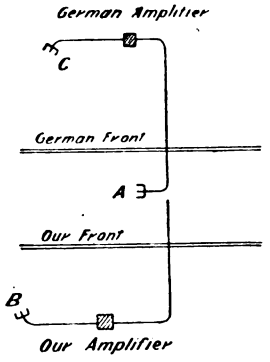

Fig 3

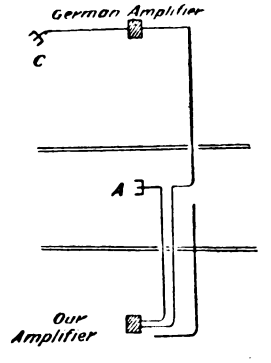

Fig 4

A good deal of information was obtained by us from the enemy by the use of the amplifiers when first installed, but the Germans soon became very cautious in their telephone conversations. They had probably learnt their lesson from the amount of information which they obtained from us by this means. They spoke but seldom, keeping their telephones for use in emergency rather than for the normal routine of trench warfare, and when they did speak they tried to hide the true purport of their conversation from eavesdroppers by evasive statements. On one occasion they unwittingly

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betrayed the presence of one of their amplifiers, and also gave away the fact that they used their amplifiers for policing their own telephones. A telephone conversation was in progress between two Germans, when a third voice intervened telling them to stop talking as the line they were speaking on was faulty and was being overheard on their amplifier. Later on they evidently considered it hopeless to prevent telephones being overheard, and came to the conclusion that the only way to prevent the leakage of information by this source was to abolish the use of the telephone altogether near the Front; evidence showed that they had even gone to the length of installing speaking tubes to take its place.

A curious occurrence took place on the Italian Front, which showed that telephone overhearing was practised on that Front as regularly as on the Western Front. A message in some simple cipher was intercepted by the Italians on one of their amplifiers. It proved, when deciphered to be one of their own messages, which had evidently been intercepted by the Austrians, put into cipher, and was being sent back by telephone to Austrian headquarters.

We were not slow to realize the danger of being overheard and we soon took steps to prevent it. The first precaution was naturally to use metallic circuits and to prohibit altogether the use of earths. Theoretically a pair of lines properly twisted and perfectly insulated was free both from induction and earth leakage. Unfortunately the average trench cable fell very short of this ideal. Only in exceptional cases was the rubber insulation protected by anything more than cotton braiding. Usually it was laid in that busy thoroughfare of trench life—the communication trench—where it was often pulled taut across the corners, threatening to decapitate everyone that passed, or if laid at the bottom of the trench it became involved in the excavations of the trench maintenance party, who ignorant of the true function of insulation were quite happy so long as the wire was not actually broken. Thus it is not surprising that the cable, quite apart from the damage done by shell-fire, soon developed earth faults along its whole length. The conductors were of a high resistance so that much earth leakage took place and such a cable soon became hardly any safer than an earth-return circuit.

The next method of preventing overhearing was to jam the enemy's amplifiers by sending a strong alternating current to earth in order to produce a noise in his receiver by which it would be rendered useless for hearing our messages. For this purpose a buzzer was constructed which could be switched on and left working continuously. Two earths were employed about five hundred yards apart in the front line. In the later patterns of this instrument the buzzer was designed to give a wavering note or a series of dashes, as this was found more distracting to read through than a continuous buzz.

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The invention of the " Fullerphone " afforded a partial solution of the problem of overhearing, since by that instrument messages could be sent in morse code without risk of being picked up. In that instrument the current is converted by an interrupter at the receiving instrument into an intermittent current, so that a direct current sent out to line is heard as a buzz in the receiver. The alternating current thus produced is confined to the receiving instrument by a suitable arrangement of condensers and choke-coils. The choke-coils also have the effect of preventing a sudden rise and fall of current in the line, thus avoiding the clicks produced at the beginning and end of a morse symbol. So long as the Fullerphone is in good condition, it affords for all practical purposes, complete protection against the overhearing of morse signals.

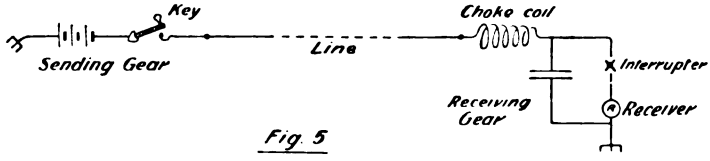

Fig. 5

It may be asked why signals cannot be picked up from a Fullerphone by putting an interrupter in the amplifier circuit. This is theoretically possible, but for practical purposes is useless for the following reason. There is always a slight difference of potential between any two earths. This potential is not constant, but varies from one minute to another, and has to be balanced by a potentiometer, which requires such continual adjustment that the reception of a message is very precarious.

One useful piece of information came through capturing a German "Interpreter-Operator," who had been a waiter in London before the war and on account of his excellent knowledge of the English language had been employed on the German listening posts to intercept our telephone conversations. He gave us some useful information regarding the German system of overhearing. He said, for example, that they used to hear our telephones so loud in their amplifiers that the operator had to take the telephone receiver off his head in order to read them. He also told us that he could sometimes hear faint signals probably emanating from an instrument which was supposed to be free from overhearing. On further inquiry this proved to be the Fullerphone. In order to investigate this we set up two Fullerphones connected to an earth-return circuit in the usual manner in close proximity to two earths joined to an amplifier. The German was told to listen at the amplifier and to hear the Fullerphones if he could. To our astonishment they could be heard, faintly, yet clearly enough to be readable. These instruments were immediately tested, and it was found that

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owing to long exposure to the damp the wooden framework of the choke-coils was only a partial insulator and offered quite a low resistance to the alternating currents produced in the receiving instrument, thus enabling them to leak out to the line. In consequence of this episode all Fullerphones in use were tested regularly. The test could be made quite simply by putting an ordinary telephone in series with the Fullerphone. If nothing could be heard in this receiver when the Fullerphone was working, it was quite safe to assume that the Fullerphone was inaudible to any German amplifier, which had approximately the same sensitivity as our own.

The use of the Fullerphone enabled us to keep up our communications through the medium of morse telegraphic signals without risk of being overheard, but it did not enable us to carry on telephone conversations unheard. One proposal for doing this was to use an amplifier for reception and an ordinary telephone receiver in place of a microphone. This however was too cumbersome for general use. Another ingenious device used a combination of earth-return and metallic circuits. The current produced in the telephone was diverted, by means of a vibrating contact, alternately to a metallic and to an earth return circuit. At the further telephone the signal strength was about the same whether the current arrived by the metallic or by the earth-return circuit, consequently connnected speech was heard. At the intercepting amplifier the earth-return signals were much louder than those from the metallic circuit and consequently confused speech was heard, which was quite impossible to interpret. In practice, however, it was difficult to arrange that the strength of the two signals at the receiving telephone were the same, so that speech was rather indistinct.

The conditions under which signalling was carried on during stationary warfare were materially changed when any movement took place. It became impossible for either side to maintain the lines and instruments necessary for overhearing, and the vital consideration was to keep up communication of any kind. The increasing intensity of shell-fire and the constant movement made the upkeep of lines exceedingly difficult. Wireless aerials were too conspicuous and were constantly being broken by shell-fire. Visual signalling was not reliable, since at the critical moment vision was liable to be obscured by early morning mist or by the smoke and dust created by shell-fire. An apparatus was needed which could signal for about a mile, requiring neither a high aerial nor long lines, which was mobile and could be worked from a protected position. It was found that the method above described for overhearing enemy telephones could be effectively adapted to this end. If instead of the enemy telephone we imagine one of our own telephones connected to two earths 100 yards apart, signals from this will be heard on an

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amplifier several hundred yards away, and messages can be sent from the telephone to the amplifier. In order to get signals over a sufficient distance a new instrument was designed called a "Power Buzzer." This as its name implies, was an enlarged reproduction of a telephone buzzer and about fifty times as powerful, and, connected (see *Fig.* 6) to two earths, forming a so-called earth base, perhaps a hundred yards long, constituted the transmitting station. The amplifier was connected to a similar base at the receiving station, with its two earths as a rule two hundred yards apart. Thus in order to send messages from one station to another it was only necessary to set up at each station the instrument with its short length of cable, which could be buried if necessary, to protect it from shell-fire. This system was introduced almost simultaneously by us and by the French, though for the most part we used Power Buzzers made by the French.

The Power Buzzer was constructed very much on the lines of a spark induction coil, with separate primary and secondary circuits. (See *Fig.* 7). The source of energy used, was a ten-volt twenty ampere-hour accumulator, the buzzer taking about four amperes in the primary circuit and delivering approximately half an ampere at fifty volts in the line circuit. The armature was designed to vibrate at a high speed, thus producing a musical note with an average frequency of five hundred periods per second..

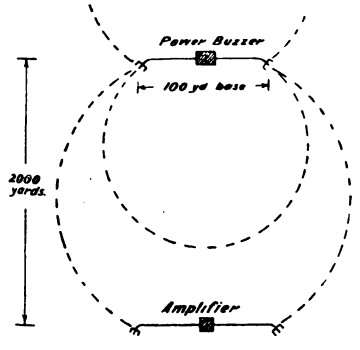

Fig. 6

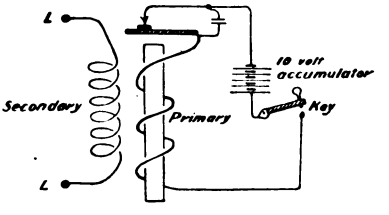

Fig. 7

The distance over which communication could be maintained with this apparatus varied considerably with the nature of the ground. In the muddy soil of Flanders signals could be obtained over a distance of two thousand yards, using a hundred yards base at each station. On the Somme, however, where the soil consists of a layer of earth about six feet deep and chalk underneath, the earth currents were for the most part confined to the surface and the possible distance was more than doubled. This effect was also observed in ordinary soil after a frost, when at the surface the soil having thawed

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was conductive, while underneath being still frozen it was an insulator. By using longer bases, communication has been established over more than twelve thousand yards.

In the course of a few months the Power Buzzer was converted from an interesting electrical experiment into a practical and simple means of communication. The instruments were improved, simplified and standardized as far as possible, and an enormous reduction in bulk and weight was effected, the amplifier for example, being reduced from an instrument weighing 60 lbs., which had to be carried about by two people, to a weight of only six pounds. Compared with other wireless apparatus the Power Buzzer had the great advantage of simplicity, and did not require such highly trained *personnel.* Both Power Buzzer and amplifier were easily tested and adjusted and were free from the complications of " tuning."

Two points which received attention during this time were the quality of the earths and the relative direction of the two bases, upon which a considerable number of experiments had to be made before the best results were obtained.

To get good results it was essential to have as large a current as possible in the earth circuit of the Power Buzzer. But we found that a certain current at a high voltage did not give such good results as the same current at a low voltage. It appeared that the high voltage had a tendency to reduce the spread of the earth currents. The only method of getting the required current at the low voltage was to use a very low resistance earth, and this proved to be the dominating factor in securing success. For a permanent earth the simplest method was a large tin buried and saturated with a solution of common salt, while for a mobile earth three or four iron earth-pins about three feet long, pushed into the earth at the wettest spot available, usually sufficed Another consideration was that the resistance of the earths should be equal to the impedence of the secondary circuit of the amplifier or Power Buzzer. This was considered to involve too great a complication for our use, but it was arranged for in the German instruments.

With regard to the arrangement of bases we obtained the best results when both earths of the receiving station lay on the same line of flow of the earth currents emanating from the transmitting station. Assuming that the lines of flow were circles, the best results were obtained when the two bases were parallel and opposite, as in this case the minimum circle of flow was utilized. (See *Fig.* 8). When three stations were working together a more complicated calculation was necessary. For example, supposing a station A was working to a station B and for this purpose had its base laid out at an angle X° with true north, when a station C wished to communicate with A the two earths R S at C would have to be laid out so that they were on the same line of flow of currents emanating from the two earths P

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and Q at A ; that is to say, that PQ and RS would have to be chords to the same circle. For the purpose of taking bearings it was sufficient to assume that they should be tangents to the same circle, *i.e.*, they should be equally inclined to a line joining their centres. If the bearing of C from A was Y°, it followed that the base RS should have a bearing of 2Y°—X°. (See *Fig.* 9). This bearing could therefore be easily found for any similar case and in order to simplify this process still further a " Calculator " was used whereby the bearing could be read off on a sliding scale.

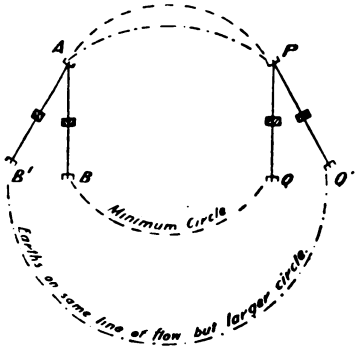

Fig 8

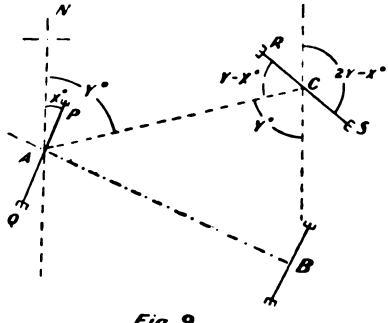

Fig 9

The Power Buzzer and amplifier were finally combined into one instrument, thus effecting a further simplification in the necessary connections and enabling communication to be carried out almost as easily as with an ordinary telegraph circuit. Thus improved, the Power Buzzer became one of the main methods of forward communication in battle, relieving considerably the burden of the runner and the linesman.

This system cannot be regarded as ideal, but it filled an awkward gap in forward communication before it was superseded by high-frequency wireless sets of more efficient design. Several difficulties were encountered whilst working it in practice, chiefly owing to the high sensitivity of the amplifier. Any telephone circuit in the vicinity of the base was overheard, and it required practice and not a little patience on the part of the operator to concentrate on the signals which he wanted to hear to the exclusion of all others. This was facilitated to a certain extent by making the Power Buzzer note of a higher pitch than the note of the average telephone buzzer, so that when heard, it could be distinguished as a Power Buzzer and also read with greater ease.

Atmospherics and stray earth currents were an almost constant source of trouble, producing crackling and sizzling sounds in the telephone receivers. During the summer of 1917 there appears to

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have been a continual magnetic storm in the earth; dwindling at nights but coming on with great violence towards the middle of the day. This was afterwards confirmed by the aforementioned German operator, who stated that the interception of our signals was almost impossible during that period. Alternating current power systems occasionally caused interference notably near Lille and also in Italy.

On one occasion an amplifier gave warning of an enemy mine near Ypres. Every night a faint hum was heard in the amplifier, not the steady hum of a dynamo, but the rapidly changing note of a motor under a varying load. This was assumed to be a motor used by the enemy for boring a mine gallery, and this assumption proved to be correct as a mine went up under one of the amplifier earths a few days afterwards.

Efforts were made to get rid of interference by tuning the receiving circuit either mechanically or electrically to the frequency of the incoming signals. To a certain extent this was effective, but the Power Buzzer signals were considerably weakened, probably owing to the number of harmonics present in the Power Buzzer note, so that a receiving circuit tuned to one of these would not get the whole signal strength.

It is interesting to note that the Germans declared that bad forward communication was one of the main reasons for their defeat at the beginning of the Somme battle. They made great efforts to improve their communications and amongst other things took up the Power Buzzer.

The German Power Buzzer was typical of German ideas on instrument making, aiming at theoretical efficiency rather than at simplicity and mobility. Every contrivance and adjustment that could possibly increase its efficiency was included, with the result that it was very much heavier and bulkier than ours. So complicated, in fact, was its mechanism that it is doubtful whether anyone but a professor of physics could really understand it and work it to its full advantage.

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THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914—1919.

BRIDGING.

CHAPTER III.

(Continued).

BRIDGING OPERATIONS—AUGUST TO NOVEMBER, 1918.

(*Reference* MAP *following* PLATE XXIV., *page* 216, R.E.J. *November*).

Haute-Deule Canal.—Lys River and Canal.—St. Quentin Canal, Escaut (Scheldt) River and Canal.—Selle River.—Canal de la Sambre.—Conclusion.

6. THE HAUTE-DEULE CANAL.

The heavy bridging of the Haute-Deule was carried out by the 560th A.T. Company, and the 250th, 257th and 3rd Australian Tunnelling Companies, all belonging to the Fifth Army.

Considerable difficulties were met with owing to the very complete destruction of the old bridges and abutments, which involved either an immense amount of clearing work, or very long new approach roads. The nature of the ground bordering the canal also made the work of assembling long span bridges rather difficult.

Projects had been carefully worked out beforehand in anticipation of an advance, and all arrangements worked smoothly. No particular difficulties were found in the actual work of erection.

Two Hopkins Bridges were put up, one of 105-ft. span, and the other 120-ft. span. In each case the actual work took about a week.

7. THE LYS RIVER AND CANAL.

The canalised Lys varies from 100 ft. to 150 ft. in width at normal water level.

When the Second Army began its advance at the end of September, 1918, every bridge was found to have been destroyed, and 17 main road bridges had to be erected or re-constructed.

Complete arrangements had been made early in September to form an Army Bridging Organisation. The *personnel* consisted of an Army Bridging Officer on the Staff of the Chief Engineer, and the 554th (Dundee) A.T. Company, R.E. This Company was specially selected as the *personnel* consisted chiefly of men who in civil life

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were engaged in the manufacture and assembling of heavy structural steel-work.

Two Bridging Depôts were formed, an Army Base Depôt at Les Attaques (Calais), and an Advance Depôt at Bailleul. Two sections of bridging stores were kept at Les Attaques, and one section at Bailleul, where in addition about 10 stock spans were kept ready for immediate use. These two Depôts proved of great value, and the system of the army running its own depôt at the base was most satisfactory.

Owing to the rapid advance of the Army during October, the forward Depôt was moved by train to Heule, North of Courtrai, on the 4th November.

The transport used for conveying bridging material and stores from the Advance Depôt to the sites of bridges consisted of two 5-ton Berna lorries, one 7-ton trailer, F.W.D. lorries with trailers from No. 9 Pontoon Park, and such 3-ton lorries as could be provided by Corps or Army.

The 554th Company was continuously employed throughout the months of September, October, and November on the following duties:—

Unloading, checking, sorting and stocking stores and bridge parts at the advance depôts.
Issuing spans and stores, and loading them in correct lorry loads.
Supervising the correct delivery of stores at bridge sites.
Repairing bridging stores and equipment, and making replacements of lost parts.
Making up complete bridges from R.S.J.'s and timber.
Dismantling bridges in back areas.
Salving bridging material in captured areas.
Assembling a power pile driver and training crew for same.

This unit also provided a little skilled *personnel* for bridge erection, and the *personnel* for the base depôt and the office of the Army Bridging Officer. An opportunity was also taken to train certain Field Companies and the 255th Tunnelling Company in the handling of steel girder bridges, and these units dismantled the Arques High Level Bridge which consisted of one 120-ft. Hopkins, and six short spans. *Photographs* XXXVI. and XXXVII. show the construction of a 150-ft. Hopkins Bridge at Pont de Nieppe.

No features of interest occurred in the actual erection of road bridges except the building of two R.S.J. heavy pontoon bridges at Halluin and Harlebeke. These were quickly put together and proved of great value in getting heavy guns across the river before the completion of the steel bridges to take A. Loads.

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The traffic across the Halluin bridge between October 23rd and November 3rd was as follows :—

Lorries	4,813
Horse Transport	1,275
Tractors and Heavy Guns	97
Steam Wagons	20
Light Cars	1,690

Some difficulty was experienced in getting certain heavy tractors and caterpillars across these bridges owing to the great width over the wheels, which is 9 ft. 6 in. in one class of tractor.

The service chesses used for decking are only 10 ft. long, and when the ribbons are fixed it is not possible to obtain anything like this clear width.

8. St. Quentin Canal. The Escaut (Scheldt) River and Canal.

Four points were selected for bridging the St. Quentin canal, but when the Fourth Army crossed it early in October, only two bridges were found necessary, as the Germans had left the other two crossings intact.

At each of the two points bridged a rectangular Inglis Bridge was first put up, and replaced as soon as possible by a 60-ft. Class A span with short R.S.J. extensions on standard piers. These two crossings were made by the 283rd and the 216th Army Troops Companies. *Photograph* XXXVIII. shows the bridges at Bellenglise. A Tank crossing was also made by the conversion of a German concrete dam into a causeway.

The Escaut (Scheldt) River and Canal, of which the St. Quentin Canal is a continuation, extended across the entire British front, and threatened to be a most serious obstacle.

On the front of the British Third Army the Escaut river flows independently of the canal, sometimes to the east and sometimes to the west of it.

The river was just passable by Infantry, but had to be bridged before guns or transport could get across.

The water in the canal was too deep for the passage of Infantry. Most of the approach roads are of necessity on a higher level than the canal itself, and the retaining banks of the canal are in many places themselves higher than the surrounding country. Under such conditions long approach ramps would generally be required, and the building of semi-permanent road bridges threatened to be a very slow process.

As the enemy was becoming more and more disorganised, the problem of enabling our advance to proceed unchecked was a highly important one. A solution was found by bridging the numerous

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locks with rolled steel joist spans capable of carrying the heaviest loads.

On the Third Army front alone there were 18 locks, and this method of bridging was carried out with the greatest success. The actual erection was only a matter of hours, and it was found possible to build such bridges during the night at a comparatively short distance from the enemy. Examples are shown in *Photographs* XXXIX. and XL.

Cambrai definitely fell into our hands on October 8th, and a large amount of bridging was done by both the First and Third Armies here. Traffic conditions through the town were very difficult owing to the wholesale destruction carried out by the enemy before he evacuated it, and bridges had to be built not only over the river and canal on the west side of the town, but also over the railway. *Photograph* XLI. gives an idea of this sort of work.

Very heavy work was also entailed in the removal of *débris* of destroyed overhead railway bridges.

On the Fifth Army front the most important bridge constructed was at Tournai, where an 85-ft. Class A span was erected by the 284th and 552nd A.T. Companies. A scheme was already complete, but work only actually commenced on the 11th November. A great deal of time was occupied in the removal of the steel-work of the destroyed bridge, much of which had to be effected by means of gun cotton charges. The river runs through the centre of the town, and this involved clearing the streets and houses in the neighbourhood, and also interrupted the work of assembling new girders. The new bridge was opened to traffic on the 21st November.

On the Second Army front the Escaut river varied from 100 ft. to 120 ft. in width at normal water level.

All existing bridges had been destroyed by the enemy, and in most cases the shore masonry abutments were also completely demolished.

The river was crossed on the 9th of November, and two R.S.J. heavy pontoon bridges were completed for all traffic before the Armistice was proclaimed on the 11th.

Six other semi-permanent bridges were constructed subsequently on the main routes. *Photograph* XLII. shows a typical series of R.S.J. span crossings; XLIII. and XLIV. are both 60-ft. Mark II. spans.

XLV. shows a bridge at Pecq consisting of two 30-ft. standard spans with three 10-ft. approach spans at each end. The two trestle piers in deep water are built on timber cribs, loaded and sunk.

9. The Selle River.

With the successful attacks by the First, Third and Fourth Armies in the second week of October, the enemy fell back behind the river

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Selle, where he took up a strong position on the eastern bank, having first destroyed all bridges and approaches.

This river was about 40 ft. wide and 5 ft. deep, running through open fields almost level with the banks, except in towns or villages. The western approaches generally sloped gently towards the river, and were almost everywhere overlooked by the enemy.

Under these conditions the work of Divisional Field Companies was very arduous and dangerous, but the heavy bridging, which consisted almost entirely of short spans, was of no particular interest. *Photograph* XLVI. shows a Bridge in Neuvilly, consisting of R.S.J. spans on a central pier of steel cubes.

During the period that elapsed between the crossing of the Escaut canal, and the Selle river, much work was done, especially by the Fourth Army, in the removal of bridges from back areas—work of considerable importance owing to the small reserve of stock spans that was left at the base. This Army also had to establish a new Advanced Bridging Depôt, and over 70 tons of bridging material was transported to an old German Pioneer Park at Bohain, where in addition large quantities of heavy timber were collected from the Army Forestry Depôt.

Bohain remained the Advanced Army Depôt up to Armistice day

10. Canal de la Sambre.

This was crossed by the Fourth Army in the first days of November. The advance had proceeded so rapidly and distances became so great that Army control had become very difficult. Bridging material was therefore despatched direct to Corps and left to be used by them to the best advantage.

A number of stock R.S.J. bridges were erected, but owing to the existence of locks, and the comparatively small destruction of abutments, these were all of short span and presented no difficulties. Typical examples are shown in *Photographs* XLVII. and XLVIII.

The Third Army reached the Sambre river shortly before the Armistice, but up to the 11th November only pontoon and temporary crossings had been made.

11. Conclusion.

Numerous other small streams and tributaries had to be bridged, and involved much work on the part of Corps and Army R.E.

A complete summary of the semi-permanent bridges erected during the advance is given below.

These bridges were all made to carry heavy loads of 12-ton axle load and over, and the great majority would carry from 17 to 30-ton loads. *Photographs* XLIX. and L. show examples of road bridges across main lines of railway.

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LI. is a road Bridge 350 ft. long of R.S.J.'s on timber trestles at Valenciennes station.

LII. shows a bridge across the moat at Vieux Condé, and is a good example of the use of steel cube piers.

The accompanying map, which is a portion of the $\frac{1}{100000}$ Valenciennes sheet, gives an idea of the amount of bridging that had to be done. The figures on this map are the numbers allotted to the various bridges in the Engineer-in-Chief's Register.

It is not too much to say that the power of the British Army to advance depended upon the speed with which the Royal Engineers could construct bridge crossings. Railways were so completely destroyed that they were totally unable to keep within sight of the advance, whilst the steadily increasing depth of territory occupied made it equally impossible for the Roads Directorate to keep pace. Fortunately, main roads in the occupied territory were generally in good condition, and once bridge crossings were made good, lorry traffic was able to proceed unchecked.

The success of the Corps in meeting all demands that were made upon it in this respect was due not only to the devotion and energy of all engaged in the work of reconstruction, but also to the less obvious but at least equally important work of organisation and training that had been done during the preceding four years.

SUMMARY OF HEAVY BRIDGES ERECTED AUGUST—NOVEMBER, 1918.

WATERWAYS.	STANDARD STEEL BRIDGES.	HEAVY TIMBER OR SALVED MATERIAL.	TOTAL.
Ancre River	14	—	14
Somme River and Tributaries	44	16	60
Scarpe River and Tributaries	28	21	49
Haute Deule Canal	7	6	13
Lys Canal, Lawe Canal, Aire—La Bassée Canal	18	9	27
Lys River	16	7	23
Canal-du-Nord	10	10	20
St. Quentin Canal, Escaut Canal and River ...	60	32	92
Selle River and Tributaries	26	21	47
Ecaillon River, Harpies River and St. George's River	13	15	28
Rhonelle River, Annelle River, &c.... ...	30	17	47
Sambre River and Tributaries	21	16	37
Miscellaneous Canals and Streams	39	43	82
	326	213	539

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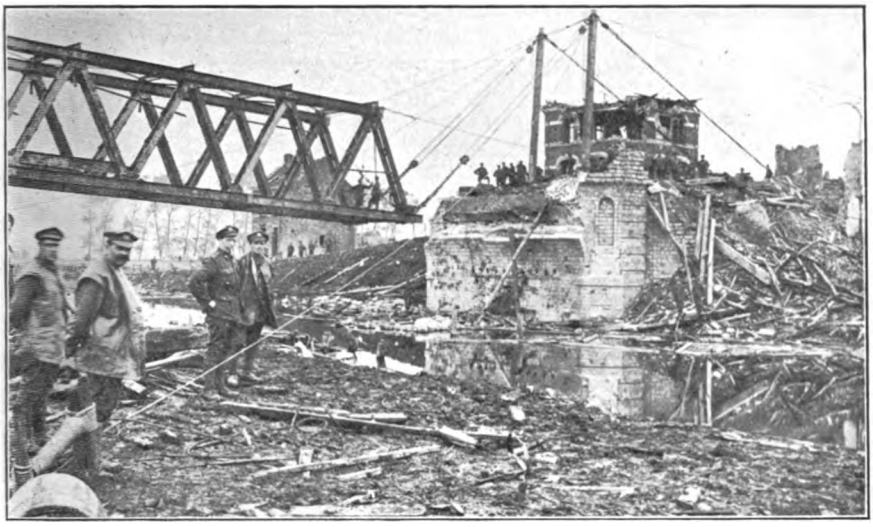
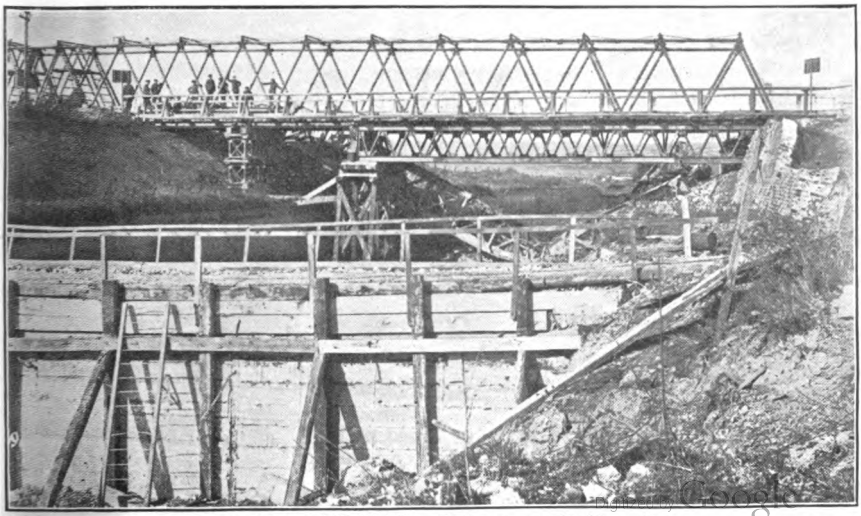
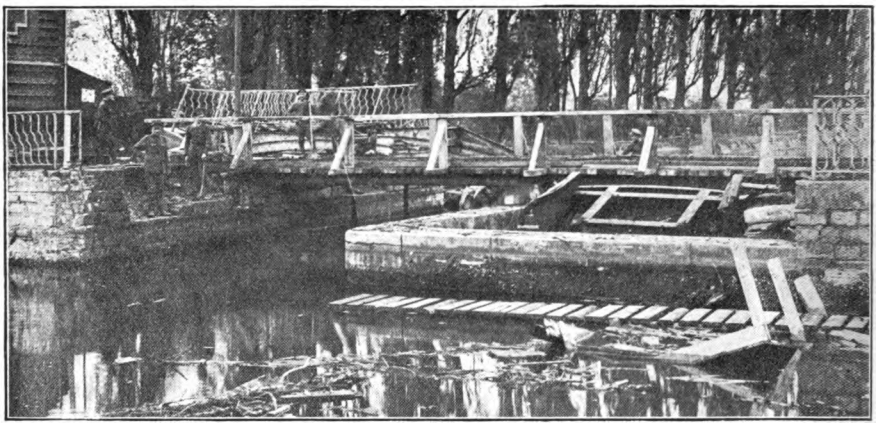


Photograph XXXVI.—Construction of 150-ft. Hopkins Bridge, Pont de Nieppe.

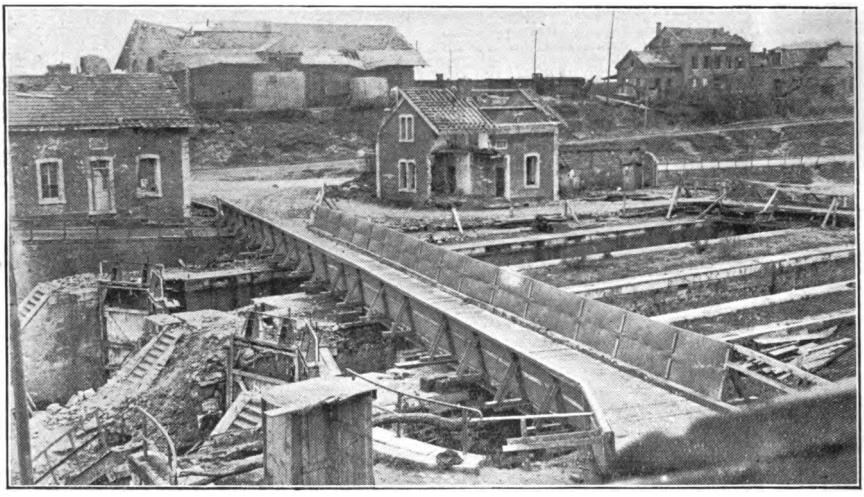
Photograph XXXVII.—Construction of 150-ft. Hopkins Bridge, Pont de Nieppe.



Photograph XXXVIII.—Bridges at Bellenglise.



Photograph XXXIX.—Bridging Locks.



Photograph XL.—Bridging Locks.

Photograph XLI.—Cambrai.

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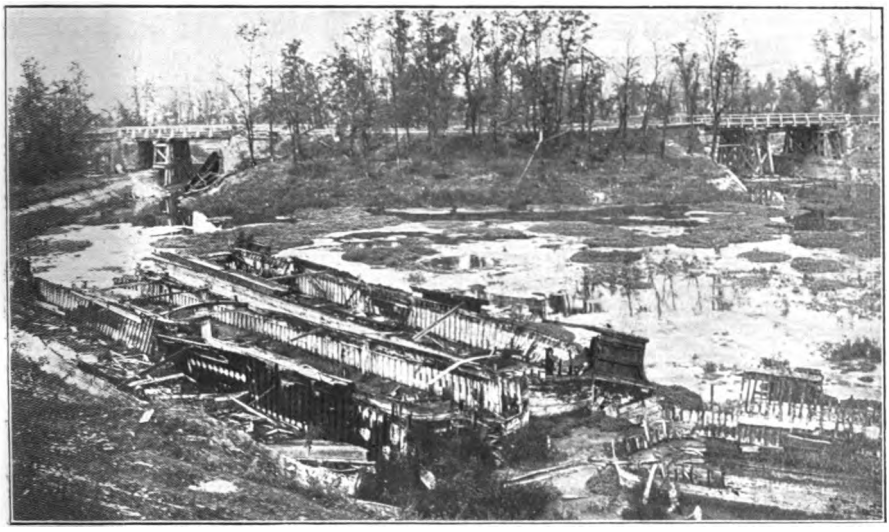
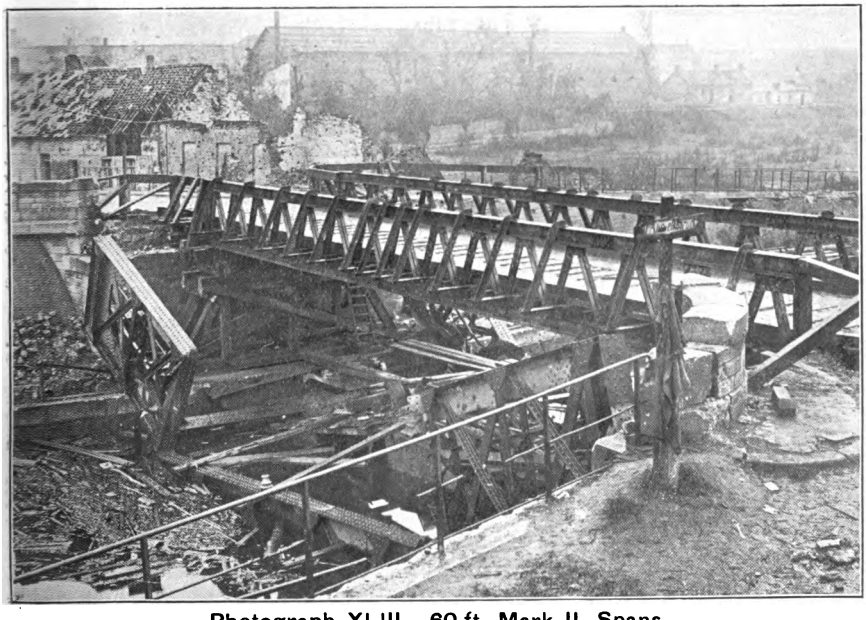


Photograph XLII.—Typical R.S.J. Span Crossings.



Photograph XLIII.—60-ft. Mark II. Spans.

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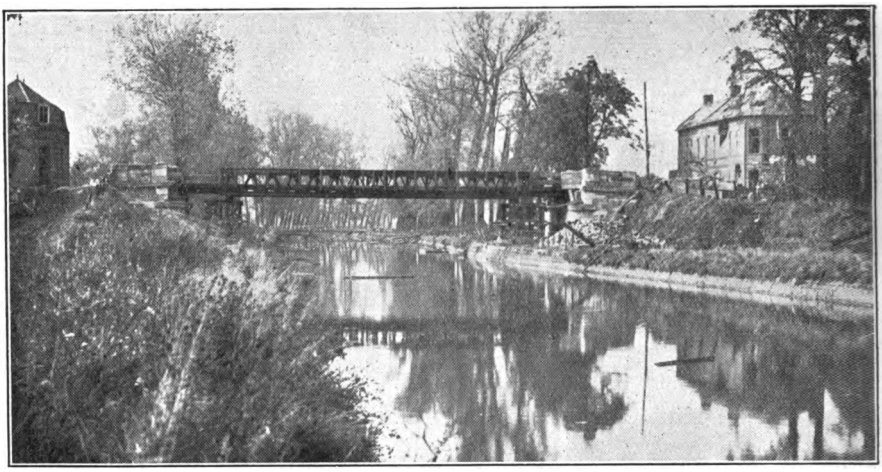
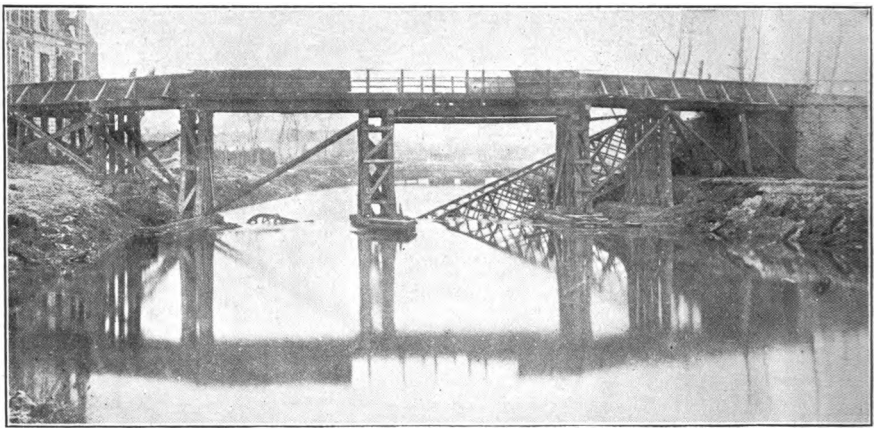
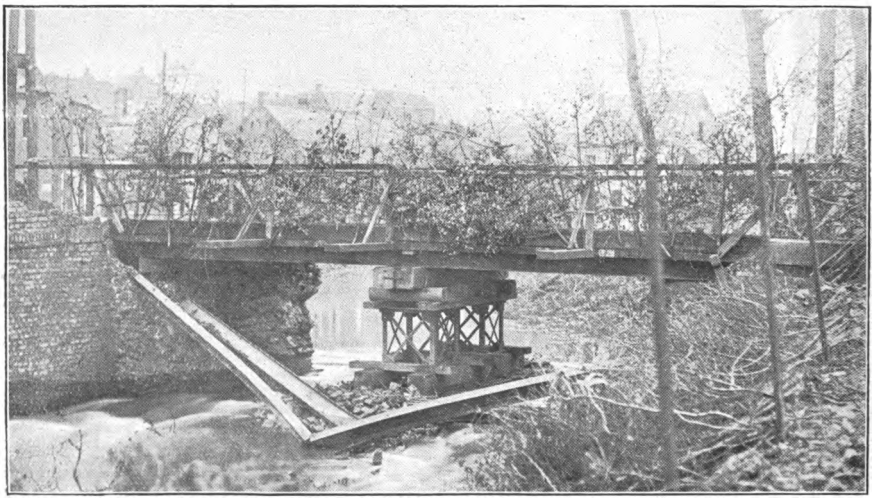


Photograph XLIV.—60-ft. Mark II. Spans.



Photograph XLV.—Pecq Bridge.



Photograph XLVI.—Bridge at Neuvilly

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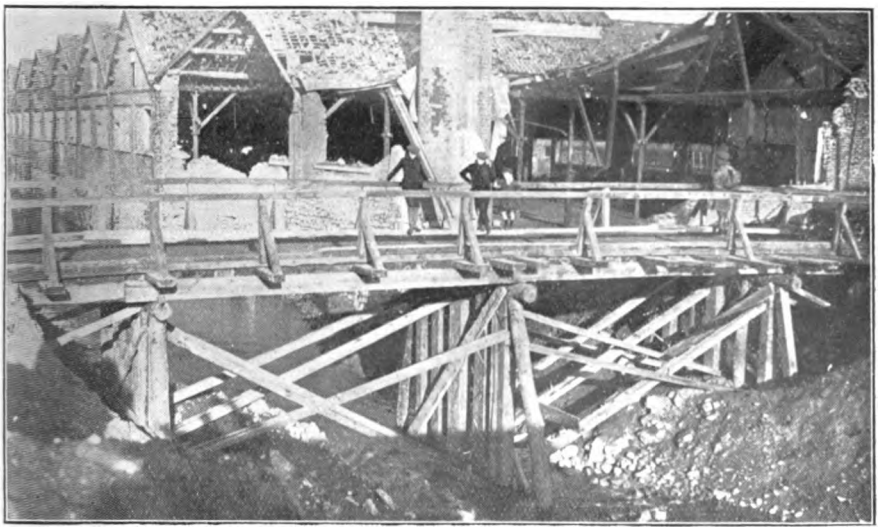
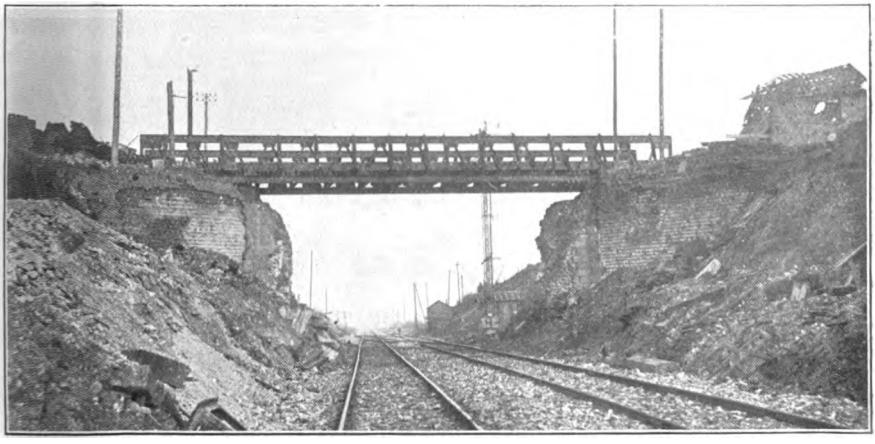
Photograph XLVII.—R.S.J. Bridges at the Canal de la Sambre.



Photograph XLVIII.—R.S.J. Bridges at the Canal de la Sambre.



Photograph XLIX.—Road Bridge across Main Lines of Railway.

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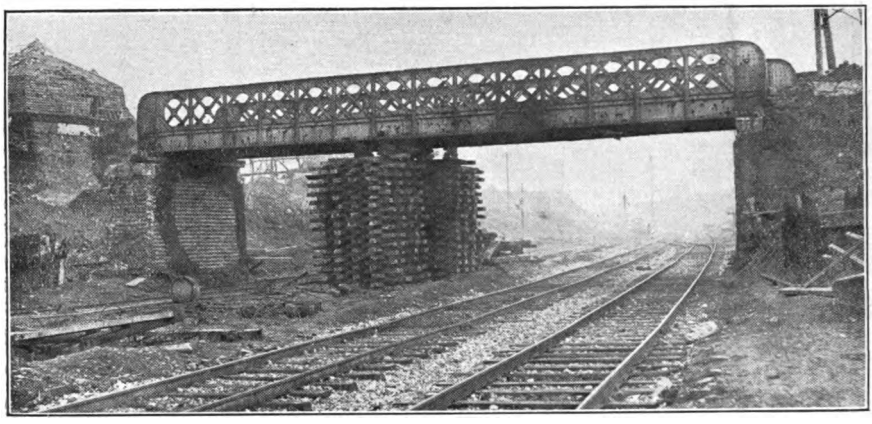
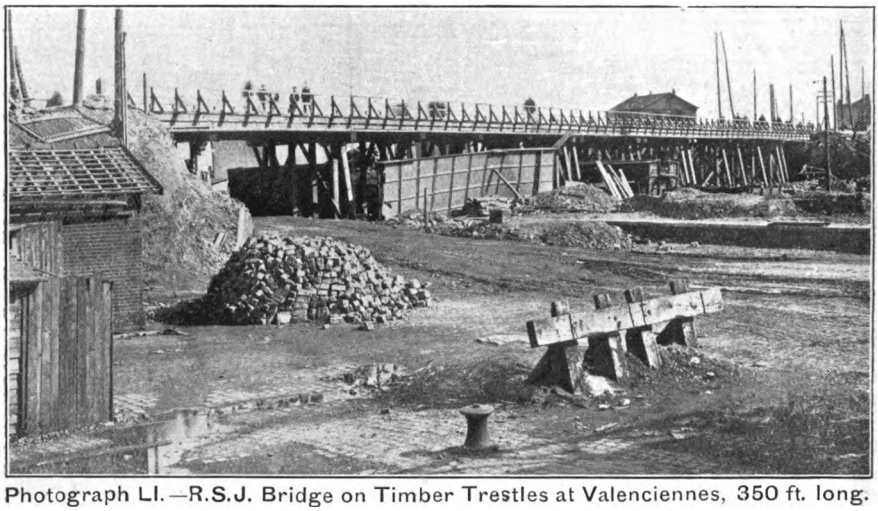
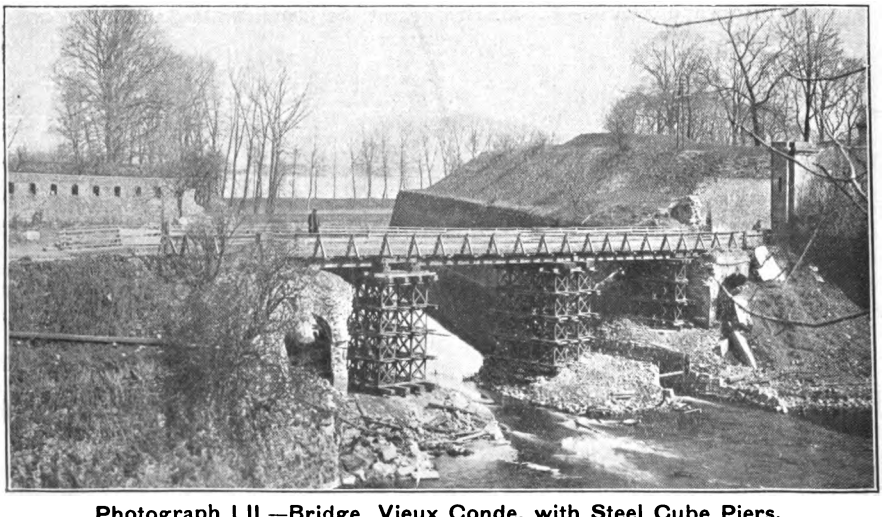


Photograph L.—Road Bridge across Main Line of Railway.



Photograph LI.—R.S.J. Bridge on Timber Trestles at Valenciennes, 350 ft. long.



Photograph LII.—Bridge, Vieux Conde, with Steel Cube Piers.

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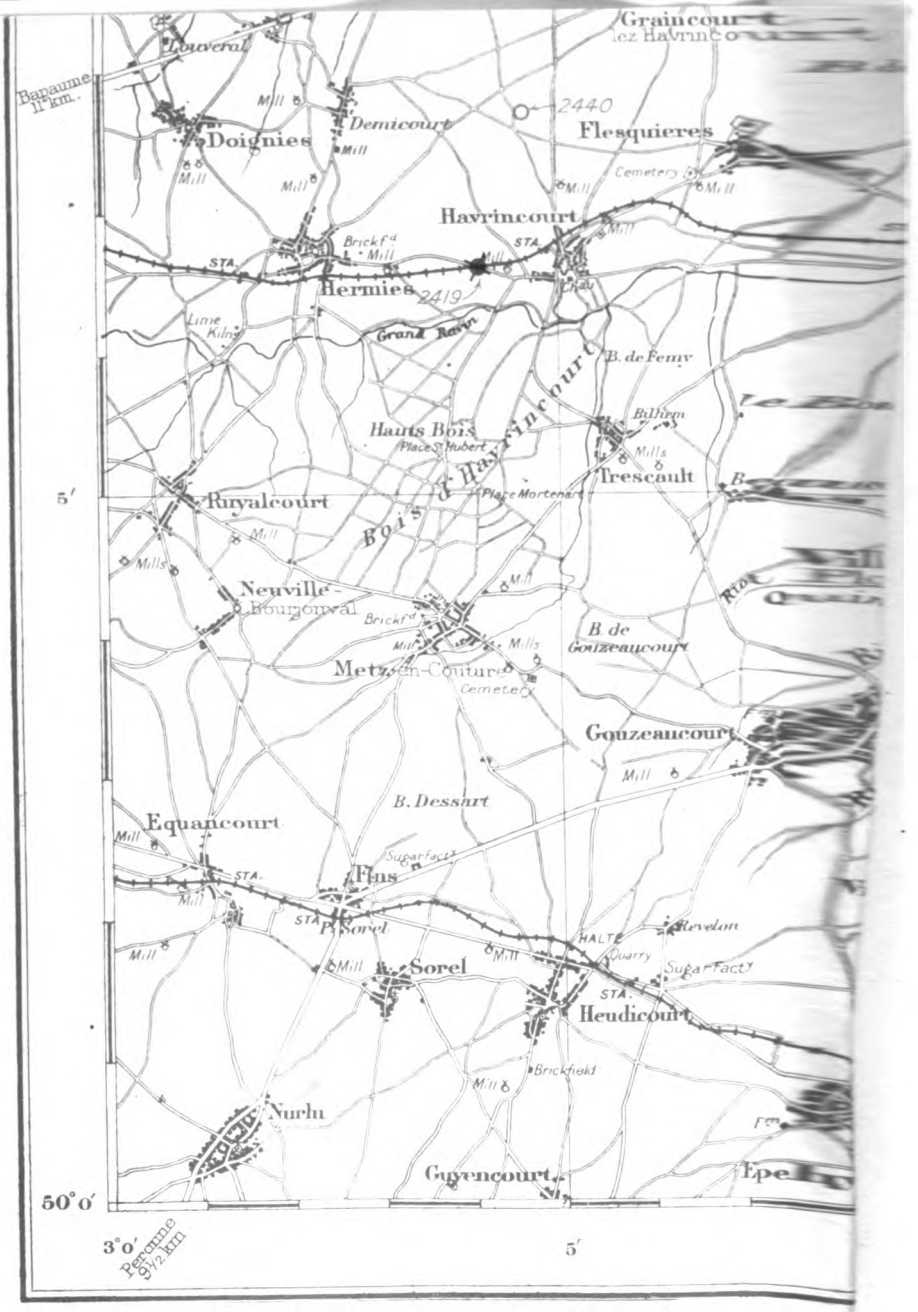
Bapaume 11 km.
Louveral
Doignies
Demicourt
Mill
2440
Flesquieres
Cemetery
Havrincourt
Brickfd
STA.
Hermies
2419
Lime Kiln
Grand Ravin
B. de Femy
Haute Avesnes
Haute Avesnes
Haute Avesnes

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FUTURE OF PERMANENT FORTIFICATION.

By Lt.-Col. J. C. MATHESON, R.E.

PERMANENT land fortification had, for a long time before the great war, become practically of academic interest only for us. Still, the existence in our army of certain technical units served as a reminder that it might fall to our lot to make closer acquaintance with examples of existing European fortresses.

During the war, however, this was not the case, except to a small extent at Antwerp. But it is necessary to bear in mind that many fortresses still exist and it behoves us not to ignore totally this branch of the military art.

In 1912, the present writer ventured to put forward* some ideas as to the direction which fortification on land was taking, based on a study of the history of the subject and the current opinion of the time in Europe.

Since then the deluge has occurred, and in all branches of war we naturally desire to take stock of our ideas and see where they need revision in the light of the flood of experience which the deluge has brought.

It will, however, be difficult to fulfil this desire satisfactorily yet as we are too near to the events which have occurred. Sufficient time has not yet been given for the digestion of reports, which concern, not only aspects of war of which we have a fair knowledge already, but also new elements which have arisen, notably war in the air.

The *R.E. Journal* has already had several articles on this subject, and as a rule the writers have dealt with it on very general lines. This would seem to be most advisable just now.

At the time of the capture of the Belgian fortresses several pronouncements appeared in the public press to the effect that the military engineer must revise completely his ideas on permanent fortification. But, as has occurred before when newspapers discuss technical matters, the knowledge displayed by the writers was very sketchy and in any case the assertion was not really justifiable.

For many years before the war numerous authorities had pointed out that fortresses like Liège and Namur would almost certainly prove to be of little use against modern attack.

* "*The Growth of the Offensive in Fortifications*," *R.E. Professional Paper*, 4th Series, No. 2.

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As far back as 1887 the anonymous author of "*Les forts et la Mélinite*" advocated the vast expansion of a work of defence into what was practically what we should now term a large defended locality, and the German "*Feste*" at Metz partook largely of the same idea. They were the most recently constructed works before the war.

The French General Langlois, about 1906, said that field fortification was tending more and more to become a substitute for the old permanent fortification, for the following reasons:—

(*a*). The perfection of firearms has given to field fortification an extraordinary power of resistance, due to the fire, not to the obstacle.

(*b*). These light fortifications escape to a great extent the effects of the artillery of the attack, not because they are strongly built, but because they are so extended.

(*c*). Permanent fortifications (of the type generally understood as such) consisting of forts of high profile but of small area, can offer only a feeble resistance to large shells. The strength of resistance lies more in invisibility and in extension of numerous and relatively feeble objectives, than in the accumulation of concrete and armour. For the latter an engine of destruction will always be found which will get the better of them.

Can we not say that the results of the war have justified the above, and do we need completely to revolutionize our ideas of fortification? One would venture to reply in the negative and to plead that on general lines fortification has proceeded in the direction forecast. Naturally on general lines only. There were many things no one had foreseen, for instance, the enormous masses of artillery.

From about 1885 onwards, continental engineers were divided roughly into two schools, concentrated fortification and dispersed fortification, the former having its adherents mainly among the smaller nations. The war seems definitely to have proved that the dispersed school was right.

At first sight there would seem to be five general points which require settlement as the result of the war. Here one would confine oneself to European continental war as we have known it. Other theatres of war, other scales of warfare, will necessitate other outlooks.

I.—As time has gone on, fortresses have expanded from the compressed walled towns (of which Le Quesnoy in the theatre of this war formed such a striking example of early 17th Century work) to such enormous "entrenched camps" as Paris with its diameter of 40 or 50 kilometres. But now, is even Paris large enough to withstand modern attack? In order to defend such a place would

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not the line of defence have to be so far in front of the object of defence that the perimeter will become so enormous that the garrison will eat up too large a proportion of the army? In other words has not the ring fortress practically ceased to exist and will not any future fortification become that of selected positions only?

II.—What type of work will be used in future fortification?

It would seem that General Langlois was fully justified in saying that the strength of resistance lies in invisibility and in the extension of numerous and relatively feeble objectives. The war has given us such examples of the resisting power of what may be called (for lack of a better term) trench systems, that one is forced to the conclusion that this dispersed form of fortification is the best for the present time. In other words, field and permanent fortification are practically merged.

III.—The Brialmont works of the Meuse fortresses have now been condemned and rightly so. But in doing this we must be careful not to be too sweeping in our condemnation of all use of dense material, such as concrete. The old forts of Verdun played a noble part in its defence and took many a hard knock, while the lavish use of concrete by the Germans in their trench systems showed that they, at any rate, considered that concrete could still be used profitably. The amount of punishment that these concrete shelters would stand was very noticeable.

The Meuse forts were tried too high and too many eggs were being carried in one basket. In the scheme of defence the forts loomed up far too much, in the same way as most of them, *e.g.*, Forts de Liers, Pontoise, etc., loomed up physically far too much on the ground. A gunner could hardly have asked for a better target. The Verdun forts had a much better chance, they were not asked to do too much.

It would certainly seem that concrete will still find a place in future works but not in large enclosed forts. Such would seem to have been relegated to the limbo of the past.

IV.—Within the limits specified before, how much fortification work can be undertaken in peace?

It would appear to be very doubtful if any fortification, in the narrow sense of the word which is generally employed, can be undertaken in peace time in the future. To construct and keep in repair a trench system on any selected position can hardly be considered as coming within the scheme of practical policy. Nor would it seem wise even if possible, to construct concrete shelters, deep dug-outs, or underground communications in peace. Conditions of all kinds change so quickly in these days that all the work might easily be useless.

So far as this class of work is concerned it would seem that all that can be done is to draw up the scheme and work it out in its entirety

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and keep it constantly up to date. But in the larger meaning of the word fortify, to make strong, actual work can be done in the vital necessity of communications of all kinds. These conclusions have already been put forward by Brig.-General G. Walker in his article published in the *R.E. Journal*, March, 1919.

V.—The war has brought forward several new features, the chief of which is aviation. As General Walker suggests, the best anti-aircraft defence would seem to be offensive action. Some local means of protection will doubtless be necessary against aircraft, but, as regards this, the actual menace of aircraft to works on the ground, by bombing, really means that aircraft constitute a very long range artillery and, up to the present, a necessarily very inaccurate artillery. A bomb dropped from an aeroplane flying at a speed of 100 miles an hour, leaves the machine with a forward velocity of about 150 feet per second. This very soon drops off and the bomb is then practically under the influence of gravity only and exposed to the impulse of the wind. So that, under existing conditions, bomb-dropping cannot be accurate, while the case of hovering or low-flying aircraft can be dealt with by anti-aircraft guns.

Summing the matter up the conclusion would seem to be that, for European continental warfare in the future, permanant fortification is merged in field (to use the old terms) and the adjective "permanent," to denote a type of fortification, might now be dropped.

This is not to say that good defences might not still be made from existing works now considered obsolete. The garrison is always greater than its fortifications, as Verdun showed.

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WATER LEVEL IN CHALK.

By COLONEL WM. PITT., C.M.G., LATE R.E.

IN the October number of the *Geographical Journal* there is an interesting paper by Capt. W. B. R. King, O.B.E., formerly Geologist to the Engineer-in-Chief, G.H.Q., France, on "Geological Work on the Western Front." In his paper, Capt. King refers to the remarkable periodical fluctuations in the level of the water table in saturated chalk and draws conclusions which, although they may be correct as regards the particular part of France to which they refer, are at variance with my own observations in England, and should not, I think, be accepted as of universal application.

What happened in many cases was that mine-galleries and dug-outs were constructed just above the water-table when at its lowest, consequently, when the periodic rise came they were flooded. A previous knowledge of this phenomenon, and of the time of year at which it occurs, would have avoided this trouble.

Capt. King gives a brief description of a typical chalk area with its valleys, mostly dry, and explains how the rainfall on the surface is absorbed into the ground and permeates the chalk until it is held up by the green sand or other impermeable stratum underneath. The lower part of the chalk thus becomes saturated with water and forms a reservoir, the surface of which is known as the "water-table." The level of this surface rises towards the hills and falls towards the valleys. It is also subject to a periodical fluctuation, being at a maximum in spring and a minimum in autumn. The explanation given is that, although there may not be much difference between the amount of the rainfall in summer and in winter, a large proportion of the former is lost by evaporation. Capt. King goes on to quote Colonel David, Geological Adviser to Controllers of Mines, 1st, 2nd, and 3rd Armies, as showing "that there is a lag of only from two to three weeks to a month between the peak of the rainfall (after correcting for evaporation and run-off) and that of the chalk water-table." What I have observed as regards this "lag" is entirely different, as I will proceed to describe, but first I will say that it seems doubtful whether there is really much loss due to evaporation and run-off.

About ten years ago an elaborate series of investigations into the subject of dew-ponds was carried out by Mr. E. A. Martin, and recorded by him in his book *Dew-Ponds*. He found that the average annual evaporation is from 17 to 18 inches, on the South Downs.

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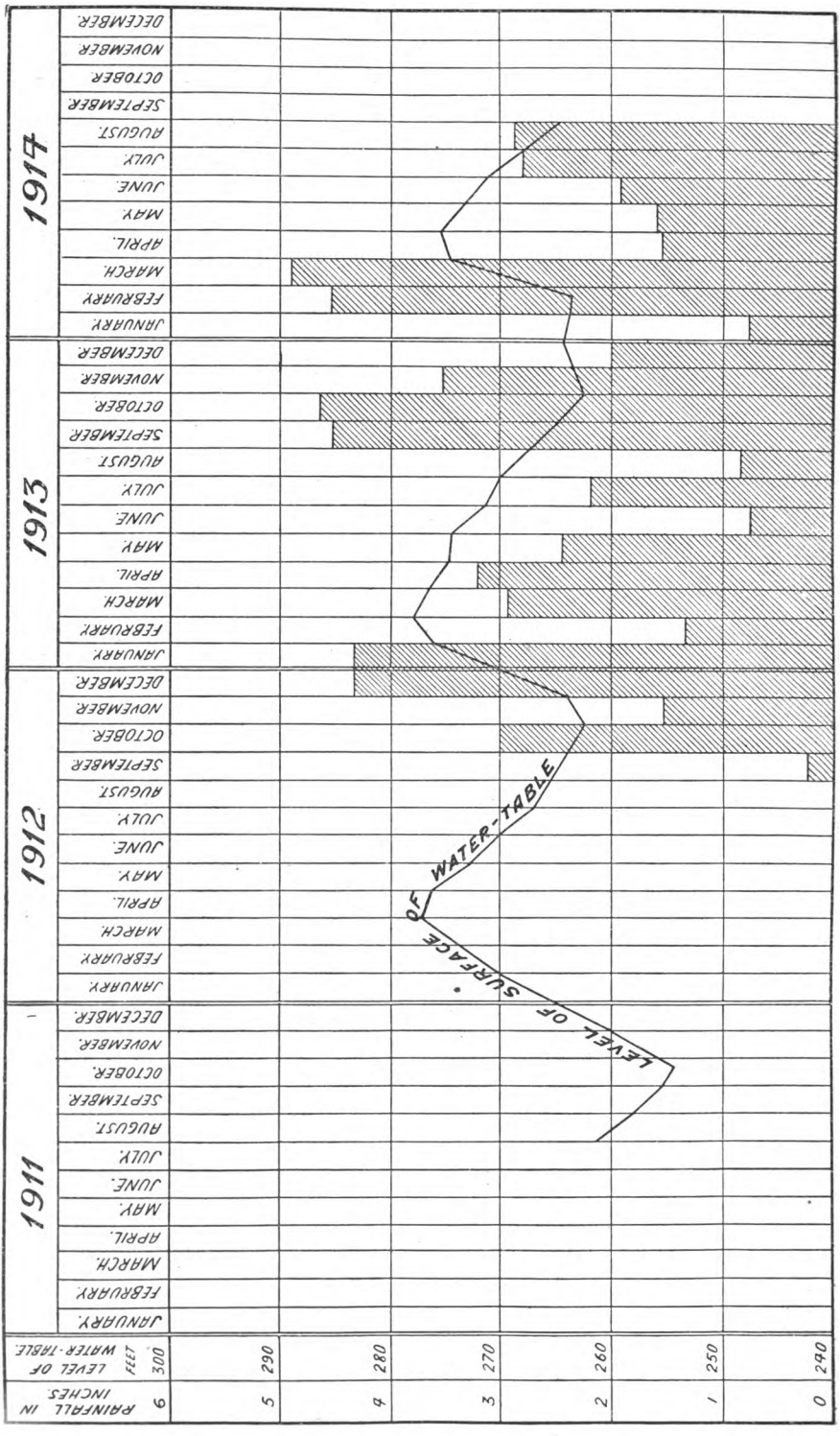

Diagram of Levels of Watertable and Rainfall at Knights Enham, Andover

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But this is the loss from the surface of ponds exposed to the sun. Rain falling on the ground quickly soaks in, especially in chalk, and it is difficult to believe that the evaporation is more than a portion of the amount stated above. Then again as regards run-off. There are rarely streams to which the water can get access and so escape. If it does not soak in where it falls it does so elsewhere and consequently is not lost.

During the four and a half years immediately preceding the war I lived on the chalk near Andover. The house stood on the 300 ft. contour, and was 19 ft. above the bottom of a shallow dry valley. The water supply was derived from two wells, one at the house and the other in the stable yard which was in the bottom of the valley. The former was 54 ft. deep and the latter 36 ft.; consequently the bottom of the house well was a foot above the bottom of the other. The distance apart was about 75 yds.

My attention was attracted by the more or less regular fluctuations in the level of the water in the wells and I soon started a record, taking measurements on the 1st of each month. The result is shown plotted on the diagram. (See Plate). This entirely bears out the fact noted by Capt. King that the level of the water-table is at a maximum in spring and a minimum in autumn, the curve being fairly regular.

Unfortunately it was not till a year later that I began to keep a record of the rainfall and to see if a relation could be established between the peaks of rain-fall and water-table. This was, however, done for two years and the result is given in the diagram.

Now it appears from this diagram that Colonel David's theory, that the peak of the water-table only lags from two weeks to a month behind that of the rain-fall, does not hold good, at any rate as regards the place where these records were kept. For example, there was heavy rain in September, October, and November, 1913, yet the water-table fell, and did not begin to rise again till the end of February, 1914. Again, from the beginning of April to the end of August, 1914, there was a rainfall increasing every month, yet the water-table fell steadily.

I was anxious to ascertain what the lag really was. To establish a definite law it would be necessary to extend the records over a long series of years but they were unfortunately brought to an end by my removal from the locality. I should not be surprised, however, to find that two years is nearer the mark than two weeks. Much must depend on the contour of the country. The place I have been referring to was near the foot of the slope of a chalk range which rose gradually for some three miles to a height of 700 ft. and then dropped with a steep scarp to about the same level, in half a mile, into a long deep valley in the bottom of which was a "winter bourne." Rain falling on this hill must soak down straight through it, some in

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fissures and the remainder through the solid chalk at an infinitely lower rate. The only outlet on reaching saturation level is at right angles to the crest of the ridge. Consequently there is a regular gradient on the water-table surface from under the crest to the point of escape. When the periodical rise of the water-table brings it above the level of the bottom of the valley the " bournes " begin to flow. It is a peculiar feature of streams in chalk valleys, where there are any, that they are fed entirely from below, as just described.

It would be interesting to ascertain by experiment the rate at which water would percolate through solid chalk. It would then be possible to calculate how long it would take rain to get through say 400 ft. This would probably run into very large figures. I have heard it stated that some of the water now flowing in the Test in Hampshire may have fallen as far back as the reign of Charles II.

The point I wish to make is this—Capt. King stated in his paper that before fixing on the level at which to drive mine galleries in chalk the local rainfall should be studied. I do not think that this is a safe guide. It would be much better to ascertain the maximum height to which water in local wells ever rises, and keep above that.

Capt. King also deals in his paper with water supply from wells in chalk, and here he rather contradicts what he said before as he states that " The gradual falling in the water-level throughout the summer and autumn was a source of worry to some of the water-supply officers, especially when rains had no effect on the steady fall of the water, until it was shown that no rise in the water could be hoped for until late in the autumn." This entirely agrees with my diagram and knocks on the head Colonel David's theory of the two weeks lag.

The subject is a complex one and well worth further investigation. It was with great regret that I abandoned my records. I still live on a chalk hill but at a height of nearly 700 ft. above the sea, and there is not a well within miles, as it must be some 400 ft. down to the water-table. Moreover, in north-west Kent the water level has been seriously interfered with by the pumping operations of the various water companies, and measurements of the depth of the water level in wells might give misleading results.

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THE BATTLE OF THE SOMME.

THE 21ST DIVISIONAL ENGINEERS IN PREPARATION AND IN THE ATTACK.

Extracts from the report of the C.R.E. 21st Division.

1. PREPARATIONS.

Communication Trenches.—During the preparatory period 6,700 yards of new trenches were constructed. Of communication trenches two, one up and one down, were prepared for each Battalion in the front line. Owing to the configuration of the ground it was not possible to arrange for all of these to start in the Bécourt Valley, and several were run from an approach trench named Aberdeen Avenue, which was doubled to allow of up and down traffic.

Where up and down trenches crossed they were taken one over the other, so that there might be no block, and in some cases this entailed a considerable amount of work. A trench named Middlesex Avenue was continued back along the whole length of Bécourt Valley to connect up with the Dressing Station dug-outs, for use as a down trench in case of heavy shelling, and a long trench was dug from Meaulte to Aberdeen Avenue, in case the valley route to Meaulte came under heavy shell fire. This trench also served gun positions about Bécourt Wood. In addition, existing trenches were deepened and improved and several abandoned trenches were reclaimed.

Assembly Trenches.—650 yards of Assembly trenches were made by blind sapping in the front area, and were reached by 950 yards of approach sap. All the spoil was got away under cover of night.

The whole system was opened up during the night of 23rd—24th June, 1916. Contrary to expectation this new trench was hardly shelled at all, and on the 1st July a party, consisting of two sections R.E., one company Pioneers, and two platoons Infantry, remained in it all day, after the Infantry had advanced, without suffering any casualties.

The Close Support and Support Lines were deepened and improved.

Communications across No Man's Land.—Blinded saps were made from two trenches, Purfleet and Dinet Street, to within about 30 yards of the German front line, and a third was commenced at the head of Balmoral Street but was not finished. It was intended that these saps should be opened up on the day of the attack to serve as communication trenches.

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Gun Positions.—Material was supplied for the construction of about 80 gun emplacements. Steel segments were used until the supply failed, and after that improvisations of rails were used with complete success.

Water Supply.—380 yards of 1½-in., and 1,450 yards of 1-in. water pipe were laid in order that water might be available close behind the front line. Tanks and barrels were placed in niches in the trenches, and storage for about 4,000 gallons of water was provided in this way, in addition to that stored in petrol tins.

A certain amount of damage was done to the pipe lines during the bombardment, but the supply was kept running, and water was always available near the front trenches.

Dug-Outs were constructed for Divisional, Infantry and Artillery Brigade, and Battalion, Headquarters, for Trench Mortar units and ammunition, Regimental Aid Posts and Dressing Station, and for Reserves in Queen's Redoubt and Bécourt Valley. They were dug in chalk and at least fifteen feet of overhead cover was allowed. There was no case of any of them being broken in. In addition, small dug-outs and recesses were made for S.A.A., hand grenades, and R.E. stores.

Trench Tramways.—A 60-cm. Decauville track was laid by the R.A. from about Bellevue Farm to Bécourt Wood. This was used to bring up ammunition, and proved of the greatest value.

A mono-rail was also laid up New Aberdeen and part of Bon Accord trenches, made of 1½-in. water pipe carried on brackets. The idea originated with an officer of the R.F.A., to whom great credit is due, It was used for getting up Heavy Trench Mortar ammunition, amongst other things. A Heavy T.M. was also taken up it, the work being done in one night which took four where there was no mono-rail. More tramways would have saved much labour. Very large working parties had to be detailed nightly for carrying purposes for about ten nights before the attack.

Roads.—A metalled track, 2,000 yards in length, was made on the south of Meaulte, for use in case the village was heavily shelled.

The main Meaulte—Fricourt road was prepared for lorry traffic as far as possible, by propping up dug-outs underneath it and bridging trenches which crossed it, and a track leading forward from Bécourt was prepared for First Line Transport by bridging trenches.

Stores.—During the preparation there was a great shortage of sawn timber and joists, and to provide these poplar trees were purchased, and were sawn up by one of the Field Companies. Timber, steel rails and joists were also purchased in Amiens.

Trench Ladders and Bridges.—Large numbers of these were provided. The ladders were used to some extent, but men preferred to climb out where shells had blown in the trenches.

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Only in a few cases were bridges placed by the troops across the trenches; they were mostly left lying at the bottom, but our own trenches did not appear to have presented any obstacle to the rear lines of Infantry.

2. The Attack.

1. It was decided that 21 points, chosen on the map, within the enemy's lines, should be converted into strong points when captured.

Three parties were told off for the consolidation of these strong points:—

(*a*). 2 Sections, 98th Field Company, R.E.
1 Company, 14th Northumberland Fusiliers (Pioneers).
2 Platoons, 62nd Infantry Brigade.

(*b*) 2 Sections, 97th Field Company, R.E.
1 Company, 14th Northumberland Fusiliers (Pioneers).
2 Platoons, 62nd Infantry Brigade.

(*c*). 126th Field Company, R.E.
2 Companies, 14th Northumberland Fusiliers (Pioneers).
2 Platoons, 62nd Infantry Brigade.

2 Sections, 97th Field Company, R.E., and 2 Sections, 98th Field Company, R.E., were kept in reserve, ready to reinforce the remainder of their companies if no unexpected R.E. work had to be undertaken.

Party (*a*) was kept in dug-outs in Bécourt Valley till zero. It was then moved into the assembly trench, which had been made by sapping, ready to move forward. The officer commanding the party remained at Infantry Brigade H.Q. in order to get early information of the capture of the ground to be occupied by the strong points. As already mentioned, this party remained in the trench all day without suffering any casualties, and at nightfall it was moved out to help consolidate the line gained by the Infantry.

Party (*b*) assembled in the trenches with the Infantry, being placed between the two leading and the two supporting battalions of the left Brigade. By some misunderstanding this party got entangled in the attack and were able to do very little consolidation work.

Party (*c*) was kept back till zero, when it was moved forward to Bécourt Valley and occupied the dug-outs vacated by Party (*a*). It remained there all day, and did not advance, as the ground which it was intended to consolidate had not been captured. At nightfall it moved out to help to consolidate the line gained.

The Reserve moved up into Bécourt Valley after Party (*c*), and remained there all day. At nightfall they were ordered out to make a fire trench across No Man's Land facing south, to join the original front trench line on to the captured position.

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The 178th Tunnelling Company, R.E., with attached miners of the 21st Divisional Infantry and two platoons 62nd Infantry Brigade, were detailed to :—

(*a*) Make the Becordel-Fricourt road fit for lorry traffic ;

(*b*) Make a track from the Bécourt Valley to the Sunken Road, leading north from Fricourt, suitable for First Line Transport and Field Artillery ; and

(*c*) Open up the blinded saps across No Man's Land for use as communication trenches, and continue the trenches on through the German lines as far as the Sunken Road.

Work (*a*) was commenced about zero and was successfully carried on as far as our front trench, despite the fact that Fricourt was still held by the enemy.

Work on (*b*) was commenced at zero and was successfully carried on into the German defences. Great difficulty was experienced in selecting a route across the German trenches as the ground was pitted with small craters. This track was used during the night of July 2nd—3rd, by the 62nd Infantry Brigade transport for getting up rations, S.A.A., etc.

Work on (*c*) was to be commenced at zero. That on the Dinet Street sap was successfully carried through, and a communication trench was made up to the Sunken Road. The entrance to the Purfleet sap was blocked by enemy shell fire. Work was commenced on clearing this entrance, but was not continued as that part of the German trenches to which it led was not captured.

In conclusion experience showed that the R.E. should be ready to move forward as soon as ground to be consolidated has been captured. Even if work cannot be carried out before dark it is a great advantage to get to the spot whilst it is light, and to know that it is the right place and see what defences are required. Where work is possible during daylight it appears to be safer to carry it out then. The biggest casualties suffered by a Field Company of the 21st Division occurred at night in a wood, when two Sections got into an enemy Artillery barrage and could see no way to move out of it. The experience of the party employed in repairing the Fricourt Road shows what can be done in a battle during daylight with the enemy in position only two or three hundred yards away.

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REVIEWS.

MIND AND METHOD IN MODERN MINOR TACTICS.

(Issued by the General Staff, July, 1919.)

The above small pamphlet, originally written by Lt.-Colonels Forster and Franklin for officers at a convalescent hospital, should be of considerable assistance in the training of company and platoon commanders, and junior officers of all arms. The difficulty of assimulating the concentrated essence of Field Service Regulations without examples is well known to us all.

This pamphlet provides many examples, and consists of a series of minor tactical problems, including map-reading and the writing of messages and orders, with a narrative and solutions, all worked out on the " allez allez " principle. It embodies the lessons learnt during the open warfare of 1918, and includes problems of the employment of the Infantry's many helpers—Artillery and Engineers, Cyclists, Machine Guns, Trench Mortars, Tanks and Aeroplanes. Stress is laid on the importance of considering human nature in all tactical situations, and the necessity for sifting evidence before forwarding reports.

A few problems on night advances would have added to the value of the pamphlet. The map is the squared $\frac{1}{20000}$ Artillery Training Map, extra copies of which can be readily obtained from the Ordnance Survey, Southampton. Altogether an admirable pamphlet, which should be of considerable use to both teachers and students of minor tactics.

E.H.K.

STRUCTURAL ENGINEERING.

By J. HUSBAND and W. HARBY. (Longmans, Green & Co.).

This is one of the best books of its kind that we have seen. Without being too bulky or detailed, it contains in readily accessible form, a great deal of valuable information. The methods of design are modern and are treated in a very thorough and practical way, and are easy to follow. Chapter I. deals with materials ; Chapter II. with loads and working stresses ; and includes Tables of Traffic loads on highway bridges, and equivalent distributed loads on railway bridges for varying spans. Table of Stones' " Range " formulae, etc. Chapter III. Bending moments and shearing force. Chapter IV. Beams. Chapter V. Columns and Struts. Chapter VI. gives the design in detail of a plate girder. Chapter VII. Lattice girders. Chapter VIII. Deflection, including the deflection and horizontal deflection of braced girders by the method of " Work." Chapter IX. Roofs. Chapter X. Miscellaneous, and tall buildings. Chapter XI. Masonry and masonry structures, foundations, gravity dams, arches, rigid and hinged, and tall chimneys.

H.L.L.

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NOTICES OF MAGAZINES.

THE MILITÄR-WOCHENBLATT.

October, 1919.

The organization of regimental clubs, the extension of the Kriegerbund and other means of keeping touch with the members of the old army still go on. The Tugendbund of 1812 should not be forgotten. There is an interesting commentary on Lord Allenby's final Palestine despatch in No. 49.

No. 39.

The Battle of the Marne.—A disappointing article by General von Kuhl (Chief of Staff to von Kluck), which criticises the books on the battle which have appeared, but adds nothing to our knowledge, except that von der Marwitz's Cavalry Corps which opposed the British was supported by a whole infantry division, not a strong brigade, as other accounts have said.

The Entente and the Great Coalition against the Russian Soviet Republic.—This article pokes fun at our puny efforts.

Rolls of Honour.—Foot Artillery Regiment No. 18: 72 officers and 1,835 other ranks killed. Fusilier Regiment No. 35: 206 officers and 3,700 other ranks killed or died of sickness. Infantry Regiment No. 70: 96 officers and 2,198 other ranks killed.

No. 40.

Withdrawal of the East Army.—An excellent account with map of the retirement of the German troops from Russia, Rumania, Turkey, etc.

Rolls of Honour.—Infantry Regiment No. 83: 105 officers, 220 N.C.O.'s, and 1,781 other ranks killed. Foot Artillery Regiment No. 4: 69 officers and 1,548 other ranks killed.

No. 42. (41 not received).

Dissolution of the Prussian Army.—This is a proclamation issued on 30th September, on the occasion of the dissolution of the Prussian Army. It recalls its history during the past fifty years and its deeds of valour during the war, and exhorts its members to continue doing their duty in the same spirit of self-sacrifice as was demanded of them in the old Prussian army. On another page a comment on the proclamation is made to the effect that it only tends to rub in the tragedy of the defeat. "The German Michel has been completely deceived. He stuck the dagger into his own heart; no one else had the strength to deal the blow"—referring doubtless, to the home-front.

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The Battle on the Marne.—A translation and criticism of an article by a French "poilu" that appeared in *The Times* of 6th September, 1919. There is nothing new in it, in fact, it is out of date and in some points incorrect, *i.e.*, when it says "Kluck withdrew the IV., V. and part of the IX. Corps" from south of the Marne to fight the battle of the Ourcq: he really withdrew the IV., II., IX. and part of the III. Corps.

New Books.—The reviewer of a book "Japan am Ende des Krieges" writes that the impression given is that Japan "is well-prepared for the inevitable settling-day with America." A book "Hetze gegen die Offiziere," by General Keim has been written as a warning to bring to notice the bad feeling that is being stirred up against officers by the Republicans (Republikanischer Führerbund).

Roll of Honour.—1st Battalion, Pioneer Regiment, No. 21: 40 officers, 100 N.C.O.'s and 1,016 pioneers killed. Bavarian Infantry Regiment No. 2: 120 officers, 284 N.C.O.'s and 2,668 men killed.

No. 43.

The Anti-Bolshevik Movement in South Russia.—An interesting account of the history of the Volunteer Army of General Denikin since its formation in the Spring of 1918, is given. It was originally under General Alexieff who, however, died in November of that year, and Denikin took over command. The advance of the Red Army on a broad front from the north in December, with no organized resistance against it, and the measures taken to counter it are described. In May, 1919, the Volunteer Army took the offensive in alliance with the Don, Kuban and Terek contingents, and supported by British supplies through Noworossisk, driving the Reds from Zarizyu, Charkow and the Crimea towards Kieff. The author thinks the Reds will never again get near South Russia if only because they are so thoroughly hated by the country-people. General Denikin, he says, desires a federative union of the Ukraine with Russia; otherwise, he has taken no part in political controversies. Neither reactionary nor Czarist he appears to be in favour of a national assembly based on equal suffrage for the future government of Russia.

Germany's Army and the Home-Front in the World-War.—This is an apologia for General Ludendorff, based on the "White Book on the Origins of the War" (Vorgeschichte des Krieges) recently published by the Ministry for War. The author says that the intention was to put the blame for the acceptance of the armistice terms on the shoulders of the German Supreme Command in the Field, but that the effect has been exactly the opposite. The spirit of the article is shown by the following paragraph: "From the details of the conferences that are published it is clear to what an extent General Ludendorff, as representative of the German Supreme Command, dominated all the other members from the Chancellor himself downwards . . . Ludendorff, like Hannibal, in spite of incomparable victories and endless devotion to his fatherland was defeated after years of war because his own nation, the home-front, deserted him. This stands out clearly from the discussions at the conference-table, by the publication of which, his short-sighted enemies have set up an honourable memorial to him."

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Officers' Gratuities and Pensions.—This is a complaint on the war gratuity given to senior officers in comparison with junior officers who held temporary commands. The writer says that disabled men have, by an organized movement, managed to get an increase of 40 per cent. to their pension. This has not been extended to officers' pensions. Again, a captain who commanded a battalion in action draws a battalion-commander's pension with 1,200 marks gratuity, whilst a lieut.-colonel on the retired list with the same pension only gets 720 marks gratuity.

Roll of Honour.—Fusilier Regiment No. 34 : 143 officers, 319 N.C.O.'s, and 2,133 men killed.

No. 44.

Disbandment of the Prussian General Staff.—A bitter plaint : "What a Scharnhorst created, what a Moltke and a Schlieffen perfected, is now to be smashed to pieces by the Entente. The Prussian-German General Staff, the heart and brain of the German Army exists no longer. The *victorious* enemy with a stroke of the pen has made an end of it.

Syria and Palestine.—A summary of Lord Allenby's final dispatch.

Appeal by the President of the German Kriegerbund.—General-Colonel von Heeringen calls upon all who have worn field-grey to join this organization of ex-soldiers. It is the most powerful of the clubs which keeps the military spirit alive and was particularly favoured by the ex-Kaiser.

Regimental Unions of the Old Army.—A further call to form these military organizations. Fifty-eight have already been organized.

Rolls of Honour.—Body Dragoon Regiment No. 24 : 14 officers killed with the regiment, 10 whilst serving with infantry and Flying Corps. Infantry Regiment No. 30 : 101 officers and 2,208 other ranks killed. Mounted Jäger Regiment No. 5 : 15 officers killed, 1 missing. Reserve Dragoon Regiment No. 7 : 10 officers and 123 other ranks killed.

No. 45.

Garrisons of the Future Peace Army.—The old Army had 340 garrisons, the new will probably have 120.

The Disbandment of the Old Army.—An official notice giving a list of 81 units that have been disbanded, but not a single fighting unit appears among them ; there are schools, parks, garrison staffs, committees, inspection staffs ; the only one of interest is the Staff College but this retains its demobilization staff.

Roll of Honour.—Foot Artillery Regiment No. 16 : 56 officers and 850 other ranks killed.

No. 46.

The Landwehr Corps in the Battle of Tarnawka (Lublin), September, 1914.—This is a very full account of the battle. The corps, under General Woyrsch fought in conjunction with the Austrians.

Roll of Honour.—Fusilier Regiment No. 36 : 104 officers and 2,558 other ranks killed ; 16 officers missing.

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No. 47.

Bolchevism and Asia.—The writer seems to hope that Bolchevism will do for the British what the rise of Mohammedism did for the Roman Empire.

France's Future Armed Strength.—France's evil conscience we are told will force her to maintain a large army.

The Demilitarized Michel.—An appeal to the German working man to wake up, and apparently take up arms again "after behaving like an elephant in a china shop."

Roll of Honour.—Field Artillery Regiment No. 15: 27 officers killed, 3 missing, 2 died, 24 N.C.O.'s and 214 men killed.

No. 48.

World Military Politics.—The usual article full of hatred of England. It quotes approvingly from von Tirpitz that England wished to continue the war until Germany was completely defeated, and, in italics, that she had been preparing and planning the war for years and nothing could prevent it.

The Manufacture of War Material in France during the War.—Extracted from *The Times*

Regimental Unions of the Old Army —The number of clubs is now 65.

Roll of Honour.—Infantry Regiment No. 46: 129 officers, 355 N.C.O.'s and 3,528 men killed; 4 officers missing.

No. 49.

Tanks.—Denies that the tanks had any success except at Cambrai and claims that the German Army was soon equipped to deal with them.

Syria and Palestine.—Some remarks by General Liman von Sanders on Lord Allenby's last Dispatch. He states that on the day of the decisive attack in Palestine, the 19th September, 1918, the total of the Turkish forces engaged, including baggage *personnel*, was under 30,000. At Aleppo 10,000 were rallied and formed in four divisions with the addition of 2,000 fresh troops. The prisoners taken could not therefore be more than 20,000, not 100,000; the other 80,000 must have been men not engaged at the front, labourers, transport, sick, etc. On the 19th September the Germans on the Palestine front were the Asiatic Corps with about 1,200 men, the German Infantry Regiment 146, with 1,600 men, and a few German and Austrain batteries. They only lost a few, mostly wounded prisoners. German prisoners almost exclusively belonged to small units such as motor columns, hospitals, intelligence, etc. As regards the 500 guns alleged to have been captured, the fighting troops on the 19th September had not anything like this number; it must be made up of old guns in the coast defences, and guns damaged and under repair. Guns had to be left behind because the horses were so weak that they could not draw them. He complains that the British had 14,000 cavalry against 1,200 Turkish horsemen, and that he lost 59 aviators because their machines were inferior to the British.

Military Jurisdiction.—A complaint, that in future the Army and Navy will be subject to military law only in war-time and on board ships of

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war. This will impair discipline and militate against peace and quietness in the country.

Roll of Honour.—Guard Schutzen Battalion and its Reserve Battalion : 48 officers and 1,403 other ranks killed ; 4 officers died of sickness.

No. 50.

The Entente Contest over the Unified Command in 1917.—A summary from French sources of General Nivelle's efforts to obtain undivided command.

The Theatre of War in France, 1870-1 *and* 1914-18.—This recalls places that were scenes of conflict in both wars.

Roll of Honour.—Guard Cuirassier Regiment : 15 officers killed, including two doctors.

No. 52 (51 not received).

Principles of the Re-organization of the French Army.—Summary of the report of the Commission of the French Senate. It may be recalled that it was recommended that the Engineers should not have a separate existence in peace, but be included in formations of other arms and take part in their work and manœvures.

The History of the English Tanks.—An account, taken from *The Times,* of the claims to have invented the tank.

The Fallen Aviators.—The total German casualties in the Air Force are given as :—In the Field-2,857 officers, 3,047 other ranks ; in Germany—584 officers, 1,378 other ranks.

Roll of Honour.—Field Artillery Regiment No. 5 : 36 officers and 340 other ranks killed.

No. 53.

The Employment of Cavalry in the World War.—An article by Lieut.-General Balck dealing with Field Marshal Earl Haig's last despatch, in which he defended the existence of cavalry. He points out that no break through was ever made and that cavalry successes were limited to modest surprises by small parties.

Field Marshal Graf Von Haeseler.—Obituary notice. This well-known peace commander died on 25th October, aged 83. In 1866 he was a captain of the General Staff of the First Army, in 1870-1 was major on the Staff of the Second Army.

J. E. EDMONDS.

REVUE MILITAIRE SUISSE.

No. 10.—*October,* 1919.

PERMANENT FORTIFICATIONS IN THE GREAT WAR.

The article on the above subject by Colonel Grosselin begun in the number of the *Revue* for July last (*vide R.E. Journal* for October, 1919, *et seq.*) is concluded in the number under notice : three sketch maps accompany the text.

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It is pointed out that the German concentration, which took place in August, 1914, was based on fortified centres, as follows :—

(*a*) The left wing on Istein, Strassburg and Metz ;
(*b*) The centre on Metz and Thionville ;
(*c*) The right wing on Treves, Mayence and Cologne.

At the beginning of the campaign, it had been the intention to make Belgium a theatre of secondary importance only. The German plan was framed with the idea that Belgian territory would be rapidly traversed and that the main operations would alone commence when the French frontier was crossed : the object of these operations was to turn the French left flank and to destroy the Allied forces by crushing them in the jaws of the pincers formed by the German right wing of manœuvre and the more or less stationary troops under the Duke of Wurtemburg and the German Crown Prince in the centre. Further, the intention was that, if the fortified zones on the French eastern frontier should prove unbreachable, the French Army, having its flank turned from the westward, should be driven down to the Juras, and there annihilated.

The Germans desired to remain on the defensive between Basle and the Donon, holding the forces in front of them ; whilst between the Donon and Thionville, if circumstances permitted, they intended to push forward.

The early phases of the War are recounted : the concentration of four formidable German Armies on the Belgian frontier on the 2nd August ; the German demand for a free passage through Belgium ; the launching of the German ultimatum ; the violation of Belgian neutrality ; the German attack on Liège on the 5th August.

The firm stand made by the Belgians at *Liège* and at *Namur* completely upset the German calculations : the effect of surprise was therefore wanting in the subsequent operations conducted in Belgium and N. France by the Great General Staff ; and the discomfiture of the Germans was to be completed on the front between *Verdun* and *Belfort*. The safety of Paris not being seriously involved, the fate of France was decided within a few weeks of the commencement of hostilities and with it the issue of the war itself. Thus is explained why it was that Namur was not attacked till the 20th August, instead of on the 5th or 6th *idem*.

After the collision at Dinant, on the 14th and 15th *idem*, the Germans believed the French to be in force in Belgium, and felt that the moment had arrived to launch their great offensive. The German right wing, which had been marking time for a fortnight or so, crossed the Meuse and struck on the 19th and 20th *idem*, but the blow was aimed into a void.

Finding that neither the French nor the British forces were in Belgium the Germans fell back on their original plan. It was the resistance of the garrison of *Liège* that deprived the Germans of all that they had hoped to gain from surprise ; thus the Belgian defence at *Liège* produced consequences of immense strategical importance.

The French concentration was likewise based on permanent fortifications ; it was covered by the *defensive system on the Eastern frontier.*

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Joffre acted on the defensive-offensive. Basing himself on *Belfort*, he attacked in Alsace on the day that the German onslaught was launched against *Liège*, viz.: the 5th August. His object was to relieve Nancy and at the same time to anticipate the Germans in Lorraine.

The French mobilization was at this period in full swing. Joffre's move failed tactically, but its strategic success was considerable: the Germans had to draw troops from *Metz* in order to disengage their centre Thus, it became possible to complete the French mobilization.

Joffre launched his second offensive in Alsace-Lorraine on the 14th *idem*, under Castlenau and Pau; his object was to weaken the German centre and right wing. To parry Pau's blow, the Germans based themselves on *Strassburg*.

Pau was successful, but Castlenau was obliged to yield ground at Saarburg. The strategic result aimed at was achieved, the German VI. Army was reinforced by three A.C.

Joffre now withdrew one Corps from Dubail and another from Castlenau in order to reinforce Lanrezac (5th Army) on his left wing.

Castlenau pushed again at Morhange and Sarreburg, on the 20th *idem*, but the Germans, based on *Metz*, had fresh troops and brought heavy artillery from the arsenal of this great fortress against the French. Castlenau, in consequence, retired on *Toul*, the Meurthe and the Grand Couronné; regions which Joffre had had prepared for defence in 1913.

Metz was a constant menace to the French and played a purely offensive *rôle*.

Pau and Dubail evacuated the Vosges and Upper Alsace without hesitation and, joining hands with Castlenau, saved the latter. The efforts made by Prince Rupprecht's Army to surround Castlenau's in *Toul* were gigantic.

Had the Charmes gap been pierced Chalons would have fallen and the jaws of the pincers would have closed on the French Army tightly.

Thus were the Germans drawn from their objective in Alsace, and hence they lost the initiative: they had to attack at points of Joffre's choosing.

At the date of the French offensive in Lorraine, the 14th *idem*, the German II. Army was engaged in a methodical reduction of the forts at *Liège*, whilst retaining at Louvain its contact with the Belgian Army.

The German I. Army, after crossing the Meuse, at Liège and Visé, marched towards *Antwerp*. The German III., IV. and V. Armies did little, apart from the capture of *Longwy*: they took up positions on the Ourthe and the Ardennes and entrenched themselves therein. After the reconnaissance of the 14th and 15th *idem* at Dinant, von Kluck, von Bulow and von Hausen attacked. The first named failed to cut the Belgians, who were retiring on *Antwerp*, off from that stronghold, but he occupied Brussels, detaching two of his Army Corps to mask the fortress.

It was not till the attack on *Namur* was begun on the 20th *idem* and the Germans had entered Brussels that the main French Army advanced, having on its left the British Expeditionary Force, which had then

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completed its concentration under cover of *Maubeuge, i.e.*, a fortified centre.

The German right wing was in a precarious position, and could have been cut off at this period of the war.

The collision between the opposing forces resulted in a formidable battle, more than 300,000 men being engaged on each side. Joffre was not able to provide for a numerical superiority on his left flank. The French were ignorant of the presence of von Hausen's Army. The advantage in the encounter lay with the Germans, in spite of the fact that the situation had been mishandled by them: they therefore recommenced the enveloping movement with their right wing. The Battles of Charleroi and Mons began on the 22nd *idem*. The French 3rd and 4th Armies were at this time on the defensive, and Castlenau in retreat in Alsace.

It is possible that had the French 5th Army (Lanrezac) pivoted itself firmly on *Namur*, covering itself behind a strongly entrenched position on the Meuse, the doom of the German right wing in Belgium might have been sealed early in the war. The Allied front might under these circumstances, have crystallized on the Franco-Belgian frontier. However, Lanrezac retired on to the line Givet—Thuin.

The British troops came into contact with the Germans at Mons and Binche on the 23rd *idem*: their right was uncovered by Lanrezac's retreat, but the operations of the French 1st A.C. helped to relieve the pressure on them S. of Charleroi.

The British forces now fell back on *Maubeuge*: this retreat will be ever memorable and redound to the credit of the "Old Contemptibles" to the end of time. It was a regular race between the British and the Germans for *Maubeuge*: both sides arrived there simultaneously. The British were able to reach the line Jeulain—*Maubeuge* on the evening of the 24th *idem*.

The strategic situation was as follows on the 25th *idem*: the German Crown Prince was held up in the plains of the Woevre and in Belgian Luxemburg by Sarrail; the Duke of Wurtemburg was immobilized and surrounded by Langle de Cary (4th Army) in the Ardennes; von Bulow and von Hausen had failed to crush the French 5th Army (between the Sambre and the Meuse); von Kluck and von Bulow had failed to immobilize the British at Mons and to cut them off from *Maubeuge*; the Belgians had managed to gain *Antwerp* and were holding out there. Castlenau was in an advantageous position at Luneville.

At this date the Allied Armies had suffered less than the German Armies, which had, so far, captured two fortresses and gained much territory but had not secured a decisive victory.

The Germans had hoped to besiege the British in *Maubeuge*; but General French succeeded in retiring to the line Le Cateau—Cambrai, covered by the French fortress.

The French Territorials, under d'Amade, issuing from Arras, defeated a cavalry division of the German II. A.C. on the 25th *idem*, and thus compelled von Kluck to move this A.C. from Valenciennes on Cambrai: on the 26th *idem* two divisions of this Corps moved on Bapaume and one division alone advanced against the British at Le Cateau. General

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French's left wing, which had been seriously imperilled, was in consequence saved. The British C.-in-C. had called on the Commandant of *Maubeuge* to cover the retirement of the British: the request was complied with; day and night every gun in the place was in action. The enemy, in consequence, found it impossible to set foot anywhere within about 10 miles from the centre of the fortress, and the detours he was obliged to make proved fatal to his chances of success.

The British retired from Le Cateau to the S. of the Somme. Had it not been for the *rôle* played by *Maubeuge*, the British would have been cut off from the French on the 26th *idem*, if not indeed at an earlier date.

Joffre decided to abandon Northern France and thus caused the Germans to conform to his movements: and it may be claimed that the eventual issue of the war was decided at this stage of the hostilities, since it was in accordance with Joffre's choosing that the Germans continued subsequently to act.

After the German enveloping movements had received a check at Cambrai on the 26th *idem*, the Great General Staff should have at once concentrated upon the capture of *Antwerp*: the choice lay between a siege of *Maubeuge* and that of *Antwerp*. The German II. Army was still in Belgium on the 24th *idem*; on the day following it entered Lille and on the 26th *idem*, it marched on Arras, only to march back into Belgium again later.

On the 24th *idem*, the first sortie was made from *Antwerp*, the Germans being driven back to Louvain.

The French counter-offensives in the Ardennes and the Woevre on the 24th, 26th and 27th *idem* should have left little doubt in the minds of the Germans that the French intended to make a stand on the Somme and the Oise. The Germans pushed onwards ignoring Calais, Boulogne and Havre.

On the 28th, 29th and 30th *idem*, Joffre delivered the Great Counter-attacks at Mezieres and Guise with his centre (the 4th and 5th Armies) and thus saved the French left wing from disaster.

At this period, Sarrail (3rd Army), defending the approaches of *Verdun*, held up the German Crown Prince (V. Army), which was attempting to cross the Meuse below *Verdun*. Meanwhile the garrison of *Verdun* harassed the German V. Army by the splendid sortie it made on the 30th *idem*. Only when Sarrail retired in order to conform to the general line taken up by the Allies, was the Crown Prince able to cross the Meuse.

Von Kluck continued his turning movement on the 2nd, 3rd and 4th September. Joffre now decided to abandon his defences on the Somme and Oise and withdrew to the Marne, with the intention, if need be, of retiring to the line of the Seine. It was at this time that the *Battle of Nancy* began: the formidable attack on the Grand Couronne was supported by 400 heavy pieces drawn from the Arsenal at *Metz*. However, the Couronne was strongly fortified and its defences rested on *Toul*.

On the 30th and 31st August, 350,000 Germans (eight A.C.) attacked Castlenau on the front Pont-à-Mousson to Dornbaste. Pont-à-Mousson and the Hill were taken by von Stranz; but a counter-attack by a French division, based on *Toul*, resulted in the recapture of this position.

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On the 6th September several German attacks were launched, the Kaiser himself being an eye-witness. However, in view of the bad news from the West the Kaiser had to return to *Metz* instead of making his expected triumphal entry into Nancy.

On the 7th and 8th *idem*, the Germans delivered their attacks against Castlenau without success At the latter date, the issue on the Marne had already been decided. The Germans evacuated Luneville, which had been in their occupation since the 23rd August. Joffre, having confidence in Castlenau and having little doubt as to the result of the conflict in the Grand Couronne, did not consider it necessary to weaken either his centre or his left in order to strengthen his right.

Colonel Grosselin next deals with the Titanic Battle on the Marne. Joffre had drawn the enemy on to his chosen line between the *retrenched Camp of Paris* and the strong place, *Verdun* ; to achieve his purpose he had sacrificed much—rich provinces and prosperous towns.

The Germans could not have attacked Paris without first dealing a knock-out blow to the French Armies : on a single sector of the fortress alone the number of investing troops required amounted to two A.C. The strategic reserve under Manoury (the 6th Army) was held ready within the defences of Paris and the French 9th Army (Foch) had been secretly sandwiched in between the 4th and 5th Armies. The great historic Battle began on the 6th September. Von Kluck was, during its progress, obliged to turn to the N.W. in order to face Manoury ; in doing so he created a gap on the 8th and 9th *idem* between his army and that of Von Bulow. Marwitz's Cavalry was utilized for restoring the German line between these two Armies. On the 10th *idem*, von Kluck and von Bulow began to retire in consequence of Foch's victory of the preceding day at Fere Champenoise, where he defeated Von Hausen, who at once retreated northwards.

It is suggested in the original article that had the German A.C. left at *Maubeuge* (viz. VII. Reserve A.C. about 30,000 men) and the two A.C.s masking *Antwerp* (viz. III. and IX. Reserve A.C.'s about 80,000 men) been available as a strategic reserve, the issue of the Battle of the Marne might have been vastly different.

Whilst Joffre's main strategic front was between *Paris* and *Verdun*, the French 1st and 2nd Armies (Dubail and Castlenau) were manœuvring independently between *Toul* and *Belfort*. The Germans did their level best to reach *Verdun* in order to lay siege to the place, but Sarrail's Army (the 3rd), in spite of the tough time it had had, was more than a match for the Germans, under the Crown Prince and von Eichhorn, in the strong positions which it held. The Crown Prince attempted to surround Sarrail in Verdun on the 7th and 8th September and for this purpose the German III. and XVI. A.C.'s and the Bavarian I. A.C. advanced on Troyon and S. Mihiel : however, owing to the vigorous and magnificent defence put up at Troyon the German attempts were foiled. The French troops on the heights of the Upper Meuse played a most important *rôle* during the Battle of the Marne. It will ever be remembered to the credit of Sarrail that he held tenaciously on to *Verdun*—the intention of the French G.H.Q. appears to have been to abandon this stronghold.

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In a recapitulation of the situation Colonel Grosselin points out that in the decisive operations ending in the Battle of the Marne, the French retirement was based upon *Belfort, Toul, Epinal* and the *Grand Couronne*: Dubail and Castlenau manœuvred between these fortified centres. *Verdun* was the pivot and *Paris* covered the left flank and limited the German movement; *Antwerp* held up 80,000 Germans; *Maubeuge* was right on the Lines of Communication of the German I. and II. Armies and caused much inconvenience in the supply arrangements, at the same time holding up the German IX. Reserve A.C. (from 30,000 to 40,000 men) and also a part of the VII. A.C., comprising special siege troops (about 60,000 men).

Finally, *Verdun* and the *forts of the Upper Meuse* covered the Allied right wing, permitting it to play an offensive *rôle*. Thus it was that 95,000 Germans were defeated by 80,000 Allies.

The "Race for the Sea" is next dealt with in the original article. The part played by the defence of *Antwerp* in connection with the operations by which the Germans attempted to establish themselves on the whole coast-line of Belgium is touched upon. It is pointed out that had it not been for the *fortress of Antwerp*, the Allies could not have made their stand on the Yser. Moreover, the whole of the Belgian Army would have been wiped out at the beginning of the War.

Colonel Grosselin draws the following conclusions from the experiences of the war:—

a. The Belgian permanent fortifications on the Meuse upset the German strategic plan.

b. By their existence alone the permanent fortifications assured the preliminary concentration of the various armies: the Meuse fortifications in the case of the Belgian Army; the defensive curtain on the Eastern frontier of France in the case of the French Army; Maubeuge in the case of the British Army.

c. The permanent fortifications held up the victorious invaders: Maubeuge saved the British forces after Mons and Cambrai; the beneficial influence of the part played by *Antwerp* and *Maubeuge* on the Battle of the Marne is incontestable.

d. Permanent fortifications form important pivots of manœuvre in connection with operations on a great scale; as for instance, *Paris, Verdun* then *Toul, Epinal* and *Belfort* in connection with the operations on the Marne.

e. Permanent fortifications constitute the bases necessary for offensive strokes: for example, as did *Belfort, Epinal* and *Toul* for the strokes against the Germans in Alsace-Lorraine; and *Metz, Strassburg* and *Cologne* against the Allies.

In the Great War, permanent fortifications by no means went into bankruptcy; they largely fulfilled the *rôle* for which they were provided; everything pivoted round them, for skill was shown in utilizing them to the best advntage.

In view of the existence of permanent fortifications on the strategic routes of Belgium, its ruler was able to insist that his country's neutrality should be respected, and eventually the independence of Belgium was thus preserved.

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Punishments.

Questions affecting military discipline and punishments for breaches thereof have for some time past been much under discussion in the Swiss Army. Colonel C. Sarasin, the author of the original article, tells us that there are two schools of thought in Switzerland on the subject: the view of one of these schools is that matters affecting discipline should be taken entirely out of the hands of individual regimental officers and transferred to military tribunals, to be duly constituted for the purpose; whilst that of the other school is absolutely opposed to the institution of such tribunals, which they consider would not only be useless but positively mischievous.

Colonel Sarasin's views coincide with those of the latter school and he gives his reasons why this is the case. He points out, *inter alia*, that the right to punish men in respect of breaches of discipline is an indispensable corollary to the right to command them: the suppression of the first of these rights, would be to diminish the second right to a vanishing shadow, and, indeed, to render the right completely illusory.

Colonel Sarasin is of opinion that reforms are necessary in the matter of the methods of maintaining discipline, the nature of the punishments, etc., and he recommends reforms, some of which may be considered by some old-fashioned disciplinarians as somewhat drastic. However, having in view the general advance in education, etc., the suggestions made by Colonel Sarasin are worthy of serious consideration.

Formerly and To-day.

Major Robert Cotton, General Staff, United States Army, briefly compares the military situation in the United States of America at the period of the War of Secession with that at the date when America threw in her lot with the Entente Powers in 1917.

The *military* population of the Southern States was some 898,180 men; but the enrolled strength probably did not, in 1863, exceed from 600,000 to 700,000 men, of whom about 400,000 were fit for the field. In March, 1865, there were some 200,000 men engaged in active operations. The casualty lists of the Confederate Army are far from complete, but records show that 133,821 men were killed in action and died of wounds and of disease. The Director of the Medical Services of the Confederate Army, in a statement prepared by him, showed that one third of the men enrolled were killed in action or died of wounds and disease, whilst another third were taken prisoners. All males in the Confederation, between 17 and 50 years of age were under an obligation to serve in the Southern Army.

During the War of Secession, the Northerners enrolled 2,320,272 men. The casualties suffered by the Federals amounted to 912,083 men; of whom 96,135 were killed in action or mortally wounded, 199,045 deserted and 183,287 died of disease.

The Northerners raised some 280 million dollars by loans for war purposes. The cost of the War of Secession to the United States of America has been computed to have reached, up to 1909, the round sum of 15,500 million dollars (approximately £3,160,000,000).

Calculated on the basis of the average of three years, the Northerners

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armed and equipped 45% of their mobilizable population and the Southerners about 90%. Little public control was imposed during the War of Secession; in matters of supply individuals and families were left to their own resources.

Vastly different was the War situation in 1917. At the date of the Armistice more than 25% of the male population between 18 and 31 years of age was serving with the colours. In the short space of 19 months, the numbers in the American Army were increased 20-fold; so that on the 1st November, 1918, 1,672,000 were serving in the United States and the Colonies, whilst 1,933,000 men were with the American Expeditionary Corps. Up to the date of the cessation of hostilities in France, 11th November, 1918, the American causalties amounted to 236,117 men (of these some 2,000 only were taken prisoners by the Germans.

On the 10th October, 1918, the Americans held the maximum extent of front allotted them, almost exactly 100 miles, or about 23% of the total length of the Allied front, which was at this date 442 miles.

Before the War the American Army was costing about 100 million dollars a year, during the War the expenditure on the Army rose to 14,000 million dollars (half of this sum being in respect of pay, clothing and food supplies). The total expenses of the war borne by the United States of America amount to 23,363 million dollars. It was announced in May last by the American Treasury Department that the United States had advanced credit to the Allies amounting to 9,370,219,000 dollars; it is probable that the Allies may be released from their indebtness in respect of this sum, which may, in consequence, be added to America's War Expenditure.

Major Cotton points out that each war becomes more terrible than the one which preceded it, and yet Governments hesitate to adopt a policy that involves due preparation being made for placing their country in a position to meet war, should it unhappily break out. Nevertheless, logically there would appear to be no choice of policies in respect of such a matter.

NOTES AND NEWS.

Switzerland.—The Reports of General Wille and of the Chief of the General Staff relating to matters affecting the Swiss Army and the part it played during the War have been recently published. It is pointed out that there is much food for reflection in these Reports, which form a sound basis for the study of reforms. Regret is expressed that political matters are touched upon therein, and, in consequence, the utility of the Reports partially destroyed.

Complaint is made of the spirit of self-advertisement which is manifesting itself in certain parts of the Swiss Military Hierarchy. Regret is also expressed that the Chief of the General Staff should have thought fit to contribute an article of a political nature to the Press; such action on his part is, it is pointed out, likely to disturb the confidence of his subordinates who have no political proclivities.

Colonel Kunz, Director of Artillery Services, has sent in his resignation owing to reasons of health. In view of the extremely important *rôle*

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played by artillery in the late war, the hope is expressed that a young and active officer, free from prejudices, may be appointed to the vacant post.

Interesting developments are foreshadowed in connection with the continued publication of the *Revue*. An invitation is issued to the officers of the Swiss Army to utilize the pages of the *Revue* for the discussion of questions which interest them most.

INFORMATION.

The Public and University Library of Geneva has decided to form a special section to deal with the literature relating to the Great War: volumes on every subject connected with the War will be included in the collection, which it is proposed to make.

Bulletin Bibliographique.—Short articles relating to several works of military interest and importance are published, including General de Maud 'huy's *Le Manœuvre*; M. Michel's *Journal du Commandant Ragnal, Le fort de Vaux*; Colonel Bujac's *La Belgigue envahie*; Colonel Thomasson's *Le revers de* 1914 *et ses causes*; and M. Edgar Milhaud's *Plus jamais*!

W. A. J. O'MEARA.

RIVISTA DI ARTIGLIERIA E GENIO.

July—August, 1919.

ON THE USE OF FIELD FORTIFICATION DURING THE RECENT WAR.

The employment of field fortification by the various armies during the recent war has followed—like every other branch of military art—a continuous evolution, corresponding to the evolution in tactics derived from the progress obtained in the methods of the offensive and defensive. Consequently, the evolution of the views shewn in the use of fortification has undergone gradually corresponding phases, the greatest in the history of war, as each year of the operations represents the synthesis of the progress derived from the experience of the preceding year.

1914.

In the first year of the war the effects of artillery fire on field works were not very powerful, and it was thought that as the simple trenches and parapets were able to resist the bombardments, so much the more the destruction of the trenches entailed too large a consumption of ammunition, of which at that time there was but a comparatively small supply in the various armies. It was also thought convenient that the strengthening of the positions should be only on a single line, as the occupation of more lines did not permit of fortifying all, and would have debarred the defenders from accumulating all the moderate available resources on a single line on which the greatest resistance would be offered.

Besides, it was considered that the reinforcement of a position should consist of a system of supporting points that would assure converging

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and flanking fire over the intervals, so that each position should be effectually occupied. Such lines, constituted on a system of centres of resistance, were necessary from the impossibility of constructing long lines of trenches corresponding to the enormous fronts assumed by the armies, and which would have characterized a war of positions when it was not opportune to resort to mobile operations. The first lines, moreover, became crowded with rifles, machine guns and other means of protection, and such an accumulation of forces weakened the defence owing to the increased losses caused by the density of the occupation and the damage ensuing during counter-attacks.

On the other hand the hope of being able soon to give to the operations a decidedly offensive character had tended to prevent improvement in the dispositions of the defence.

But, subsequently, owing to the prevailing deficiency of the forces in conflict with the enemy, the troops soon became constrained to withdraw into stronger trenches in order to resist the increasing power of the artillery. So, the field operations came gradually to assume the character of a war of positions with a tendency to immovability and equilibrium.

1915.

In the second year of the war the organization of the positions comprised generally:—A line of combat reinforced by positions of recovery and guarded by lines of barbed wire, and a zone of positions of recovery behind. Such a defensive position, of little depth, was occupied by half of the forces extended in line, the other half being encamped in a zone in the rear, as far as possible defensible. Numerous approaches for reinforcements or evacuation completed the system, and sometimes from these there extended short lengths of subsidiary trenches to which the troops exposed during the periods of bombardment in the lines of combat, were able to retire.

The barbed wire was hitherto restricted to lines—owing to want of material—which could be demolished by hand (with pincers, scissors, explosive tubes, etc.).

But when the artillery fire increased in intensity, owing to the continuous increase of guns and mortars of large calibre, these single lines of defence were abandoned, since they were easily destroyed, and the penetration of the enemy by surprise attacks became facilitated. It was then thought better to apply the system of echelons in depth without, however, diminishing greatly the occupation of the first lines, which continued the defence only with the fire of rifles and machine guns, as the artillery had not then adopted the system of barrage fire.

Therefore, towards the end of 1915, there existed a system of successive trenches, up to four or five, in communication with the approaches, and furnished with barbed wire and other obstacles, and also having flanking fire by machine guns and light artillery both near and at a distance. There were generally:—A line of advanced posts; a principal line of combat of greatest resistance; a line of resistance for the supports; and a line for reserves. Such a defensive system took additional strength from natural centres of resistance (villages, woods, heights), or artificial redoubts or forts protected by barbed

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wire. Sometimes in order to ensure the best resistance, two or three such masses or groups of defence were organized, adapted to the ground and of variable depth.

1916.

At the commencement of 1916, the new methods for obtaining concentration of fire by masses of artillery of great and medium calibre rendered covered trenches useless and dangerous. These, in fact, under a violent bombardment were soon reduced to ruins which crushed the defenders, and obstructed the passages. Accordingly, the preference began to be given to simple trenches, with movable planks or gratings, and to deep dug outs, small and numerous in preference to few and large, for the protection of the troops during bombardments. Such dug-outs had a depth of about three to four metres below the ground, in gravelly soil about four to six metres, in clay soil about seven to eight metres, and in moist earth with floors of cement or concrete. It was recommended to conceal all view of the trenches, the barbed wire and the parapets, and to mask the approaches and the artillery, etc., as far as possible from the enemy's fire. Barbed wire of great depth was also used, flanked by numerous machine guns, well concealed, which prevented the enemy from closing in on the ground in front.

* * *

All the principal lines of defence were about a kilometre in depth and generally consisted of three successive trenches in which were disposed the riflemen, the supports, and the reserves, at about 100—200 metres between the first and second trenches and 600—800 metres between the second and third trenches. Natural strongholds (villages, canals, woods, etc.), or artificial systems of trenches were made use of as centres of resistance. Supplementing the principal defensive lines parallel to the front, the Germans made great use of the lines of approach, traversing or diagonal to the front, as secondary lines of defence for eventual offensive on the flanks, and to form a kind of trap in which the enemy would be exposed to homicidal converging fire.

Another characteristic of the German defensive system was the great number of approaches of assault thrust forward and eventually joined in a manner to form in a short time a new trench nearer to the enemy. The Germans also arranged their lines of barbed wire in front of the first line to cover large stretches of ground, about 60—100 metres, in order to constrain the enemy to consume large quantities of ammunition for their destruction. The dug-outs were excavated with much care, and with protected approaches. They were constructed with two stories, the upper ones well ventilated serving as dwelling and sleeping places; the lower ones for a secure refuge against intense bombardment.

The masking of the works was always a matter of the greatest care with the Germans (nets, mats, boughs, etc.).

1917.

During the spring of 1917, owing to the increasing employment of great masses of artillery of every calibre, supplied copiously with ammunition, especially against the visible lines (barbed wire, trenches

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and roads) it became still more necessary to locate the troops at a depth below ground, and to conceal both them and the system of defence from the view of the enemy.

From the experiences of the war made by the various armies the general organization was as follows:—A line of observation with vidette posts, or listening places; a line of resistance, without dug-outs, at from 50—100 metres from the former; a line of circulation with small shell-proof dug-outs at 20—50 metres from the preceding; a line for reinforcements at 150—200 metres from the last mentioned, with blinded and shell-proof dug-outs; finally a line for the reserves with light trenches at 200—300 metres in rear. These several lines were in communication with the approach trenches.

The trenches were usually spanned with movable planks for about two metres in width to allow of the passage of ambulances, and had traverses, of about four to seven metres in width, in places where it was otherwise impossible to obtain protection from enfilading fire. They were also provided with numerous obstructions of barbed wire, *chevaux de frises*, and other movable obstacles. The whole of the defensive system was well concealed from the enemy's observation and preserved in every particular the natural aspect of the ground.

1918.

In the last year of the war it was confirmed from long and varied experience that the defence of a position is based essentially on resistance to bombardments; on dug-outs affording protection for the men; means for action in their vicinity, invisible and invulnerable concealed works, etc.; on its own flanking fire, which especially requires numerous machine guns; and on counter-attacks. It was also confirmed by experience that in tracing the lines of defence, the scheme should be founded on the fundamental tactics for the employment of the available troops and not on pre-conceived ideas.

From a comprehensive view of the evolution of the military art during the recent war it may be seen that the details should especially be governed by the means best adapted for preserving the men, at the expense of material. Towards the end of the war of still greater importance were surprises—by means of artificial smoke, tanks, etc., in order to obtain great issues with a minimum of forces and sacrifices.

It became also of increasing importance to use new technical detachments, corresponding to the new means of offence and defence, applying to them the principle of the division of labour. Defensive tactics consisted principally in the co-ordinated employment of offensive weapons, to break up the enemy's distant attack, and to crush the waves of assault, while waiting to launch forwards the counter-attacks.

Finally, the physiognomy of the strife tended always more towards mobility, the fortifications conserved the functions of a precious shield for the protection of the defence, but always with a less rigid character, and with a tendency to occupy a zone of depth sufficient to present an elastic resistance, and to gain the time required to concentrate the greatest number of troops.

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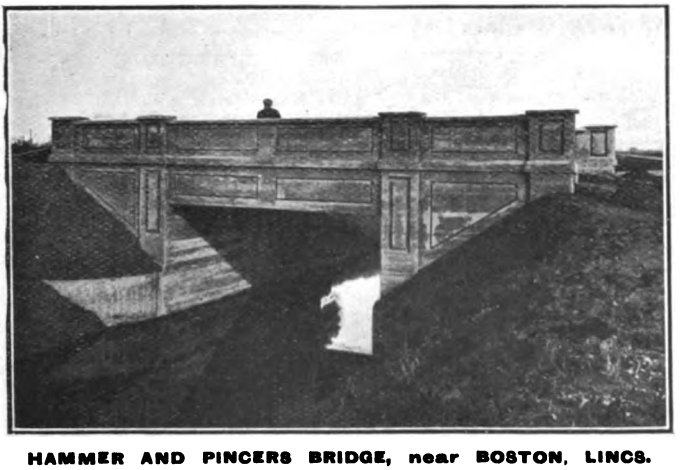

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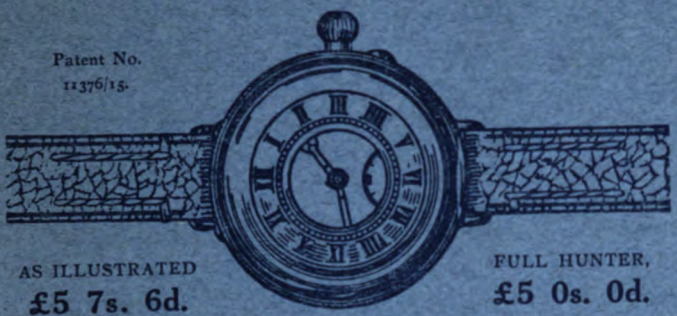

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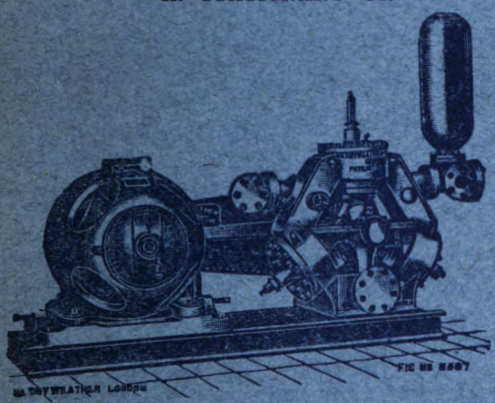

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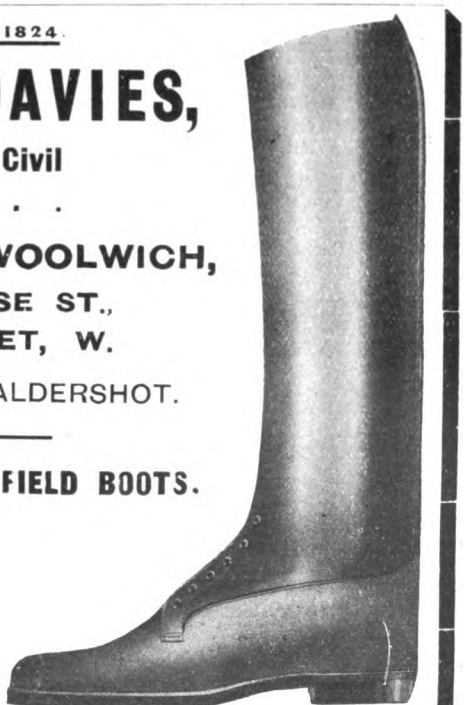

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1. The Prize shall be awarded by the R.E. Institute Council in the manner considered best for the encouragement of contributions on professional subjects, by R.E. Officers, to the Corps publications. From the beginning of 1920 it has been decided that the Prize shall be confined to Officers on the Active List not above the rank of Substantive Major.

2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography, or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

3. The name of the recipient of the Prize shall be notified in the Corps publications; and copies of the contribution for which the Prize was awarded shall be presented to the representatives of the donors.

The following are suggested as subjects for contributions:—

(*a*). Descriptions of works actually carried out in peace or war.
(*b*). Inventions.
(*c*). Design (excluding works of defence).
(*d*). Labour organization on work.
(*e*). Scientific investigations generally.
(*f*). Accounts of exploration work and surveys.

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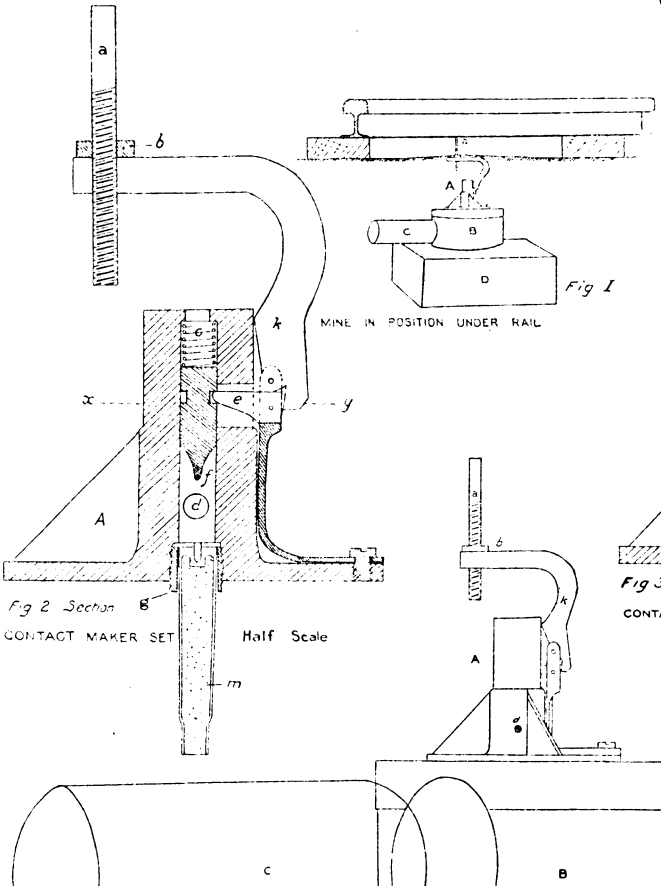
RAILWAY CONTACT MINE.



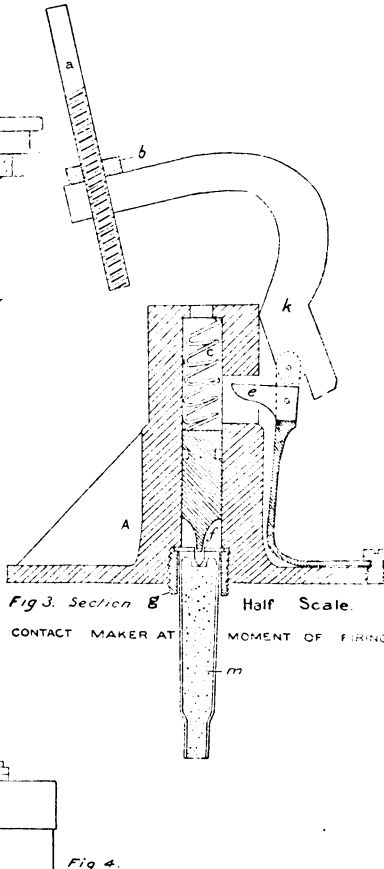


Fig 4.
ELEVATION
Quarter Scale.

DETAILED DESCRIPTION.

A. The Contact Maker.
B. Cylinder of about 5lbs. dynamite in solid mass.
C. Cylinder of mixed explosives, about 5lbs.
D. Additional number of dynamite cartridges—usually about 20lbs. in a wooden box

The Contact Maker (A), *Fig.* 2, consists of a brass casting some 3½" high, bored axially to con tain a spring (*c*) and a striker (*f*), much like those of a rifle. When the spring is compressed, th striker is retained in its "set" position by a metal stop (*e*). This stop is connected with the sprin release (*k*), which is fitted with the adjustable pointer (*a*) at the upper end. The construction of th spring release is such that, when a vertical pressure is applied to the upper end of the pointer (a (in the direction of the arrow), the stop (*e*) is withdrawn and the striker is released (*Fig.* 3). At th lower end of the vertical channel, in which this striker runs, is attached the screwed socket (*g*) whic retains a cartridge (*m*) (·303 or ·450) with its base against the lower end of the said channe Consequently, when the striker is released (as explained above) its point will strike the cap of thi cartridge. This cartridge contains dynamite. Safety in manipulation of this Contact Maker i ensured by a safety pin, which crosses the striker channel at right angles by means of the tw opposite holes (*d*), thus intervening between the striker point and cartridge cap.

The base of the Contact Maker stands on the top of a tin cylinder, filled solid with broken u dynamite. The cartridge (*g*), which projects below the base, is inserted into a prepared hole in th centre of the top of this cylinder, and communicates its explosion to the mass of dynamite within.

There is usually a second cylinder of mixed explosives (C)—guncotton, nitro-powder, dynamite etc.—introduced into the cylinder (B) through a hole in its side, and detonated by its explosion The object of this cylinder (C) is not very obvious (none of the explosives used being any mor powerful than dynamite), unless it is used to economise the latter.

The cylinder (B) may also have an additional box of dynamite (D) beneath it, containing perhap 150 sticks (20 lbs.).

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RAILWAY DEMOLITIONS AND REPAIRS.

By CAPTAIN H. L. WOODHOUSE, M.C., R.E.

IN *R.E. Journal* January 1919 there are some notes on demolitions carried out on the Hedjaz railway. The Indian Railway Sappers and Miners had considerable experience both in East Africa, and later in Palestine, of repairing demolitions, and the following notes give some idea of the interruption to traffic caused by the various types of demolition.

Though the two countries differ in almost every respect in that in Africa the line usually runs through thick roadless bush, in which animals cannot live and motors can only move along a few tracks, still, so far as the railways themselves are concerned, they are much alike, being lightly built narrow gauge lines intended for light traffic, and lacking the repair shops and complete equipment of a standard European line.

Railway demolitions fall into two quite distinct categories. There are the hasty demolitions carried out by raiding parties, in which the time for work is usually limited; and the more deliberate destruction of a line to deny its use to an enemy when an army is retiring. Both types had to be dealt with in East Africa.

Blowing up a rail by itself is hardly worth the trouble, unless a large number are done together, and the enemy is short of permanent way material. If this is done, the method of laying guncotton under a joint gives the best result. It is very difficult to straighten a vertical bend; particularly if it comes so near the end of the rail that, when the screw of a jim-crow is placed where the bend begins, one of the claws comes beyond the end of the rail—that is when the bent portion is less than twelve inches from the end of the rail. There was only one case in East Africa of a charge being placed under the middle of the sleeper as was done on the Hedjaz railway. Then the sleeper was wooden. Beyond shattering the sleeper no damage was done. On the Voi-Maktau military railway this sort of attack was an annoyance, as the grades were so steep (4% in places), the curves so sharp (14 degrees), and the bush through which it ran so thick, that after such an explosion was heard trains had to crawl till the line had been patrolled. Otherwise they could not stop in time to avoid a derailment. The sound was no guide to the position of the explosion, owing to the way it was affected by the hills through which the line ran; but at first the enemy kindly gave

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the necessary information by cutting the telegraph wires at the same time as the line. Almost as much delay was caused several times by explosions in the bush, as the line had to be patrolled to make sure it was intact. Whether these explosions were caused by raiding parties of African troops who found the line difficult to approach, and exploded their dynamite in the bush to give audible proofs of their action to their main body, or whether they were due to other causes, was never ascertained.

Considerable results can be obtained either by exploding a mine under a train, or by loosening a rail and thereby derailing the next train. In both cases it is the derailment, not the damage to the track, that gives the trouble. If this can be arranged to take place where a diversion is impossible, as for instance in a deep cutting or where the line runs along a steep hillside, so much the better. The former is better, as in an emergency trucks can easily be thrown down a bank to clear a line, though engines are usually too precious to be treated this way.

At first the enemy in Africa used observation mines, but after an incident when a whole train jumped a gap 2ft 7in long which he had blown out of the rail, and the raiders had lost their exploder in their hasty retreat, he used contact mines with considerable success. The charge was about 50 lbs. dynamite and the firing apparatus is shown in the diagram.*

The apparatus was buried in the earth of the permanent way, the top end of the pointer (*a*) alone projecting. This end made contact with the under side of a rail, with the help of the adjustable back-nut (*b*). On passage of a heavy vehicle the rail sank slightly, depressing the pointer and firing the mine.

The damage done to the engines by these contact mines was a serious matter, as at that time engines were none too plentiful. To save them, one or two sand trucks were run in front of all trains to take the brunt of the explosion. As this reduced the capacity of the trains, loaded waggons soon replaced the sand trucks. On one occasion when a mine exploded the damaged waggon was unfortunately loaded with whisky. An apparatus was captured intended to reply to the sand truck arrangement. It was much the same as the ordinary exploder, but had a ratchet in addition, which, working by the depression of the rail as each wheel passed, finally withdrew a safety pin after a given number of wheels had passed. It was ingenious, but did not work in practice.*

These mines were generally laid by night. The raiding parties

* Specimens of these two types of contact mines, and also of a third, a modification of the first, intended to catch patrolling trolleys, have been presented to the R.E. Museum by Lt.-Col. R. L. McClintock, C.M.G., D.S.O., Superintendent of Park, 2nd (Q.V.O.) S. and M., to whom the Institute is also indebted for the attached diagram. (ED. *R.E.J.*).

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had to make their way across a waterless desert, in some places 80 miles wide, and preferred to have a good start of any pursuit. By day the line was watched from small sentry posts at the end of, or in the middle of, each straight. Any suspicious party on the line could be easily seen. The defence was more difficult at night, and was finally solved by sending out groups of six men at dusk who established posts about a mile apart and kept two men on continuous patrol along the line. This ensured that no part of the line was left unvisited for more than half an hour. Experiment showed that it took about forty five minutes to bury a mine. Once planted nothing but a thin rod, which was very difficult to detect, showed above the earth ballast. In the early days when the ballast almost touched the rail throughout, detection was very rare ; but afterwards the ballast was sloped away from the centre of the track, and a gap of two or three inches was left between the rail and ballast. Even so, when mines in place were spotted it was generally due to the disturbance of the surface. One hundred rupees reward was offered for every mine discovered. In addition to the men watching on the line, patrols of intelligence scouts, operating on the tracks leading from enemy territory, were useful in giving warning of the presence of raiders in the neighbourhood.

The enemy protected his line in much the same way. But its comparative immunity from attack was chiefly due to the help given by the natives living in the range of hills immediately north-east of the railway ; who, being under the influence of the missionaries there, stopped our parties.

The most successful instance of tampering with the track occurred on the German Central railway. A party of South African cavalry loosened an outer rail on a curve, where the line ran on a high bank on a steep down grade through the usual thick bush. The train conveying the German rearguard, retreating down the line before our main body, was completely wrecked.

Bridges were only damaged on two or three occasions. In one case there was no guard, on another the enemy approaching to very close range under cover of the thick bush surprised the guard. The small parties which occupied blockhouses on either abutment, joined by a continuous belt of barbed wire, were too much for small parties to tackle.

The raiders were never strong enough to adopt the method of turning over the track complete. In Palestine, after the armistice, a track had to be replaced which had been disconnected at every second joint and turned over. Almost every length had to be pulled backward or forward for a few inches to bring the ends of the rails together. Before fast running could be allowed the whole length had to be packed again.

After the invasion of German East Africa began, the problem of

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repairing the enemy lines arose. The track had been dismantled at intervals for the first thirty miles of the Northern railway, and the points and crossings blown up. At first the fishplates and bolts, the bearing plates and clips had been removed and hidden ; later the nuts had been knocked off the clip bolts with a heavy hammer, and only the fishplates and bolts removed. The rails, and sometimes the sleepers, were thrown down the banks or into the ditch. Some of the small stores were thrown into rivers and were irrecoverable ; in other cases they had been buried. Most of the latter were recovered from information given by natives, or more frequently from the grass and branches, used to camouflage the newly turned earth, withering and showing up conspicuously in the jungle. The search for this material took time, and finally it was found to be quicker to relay with British material. The shortage of clip bolts was not very important as, if four out of the eleven sleepers per rail were clipped on the straight, slow traffic could run. The fishplates were much more trouble, especially on curves. Various improvisations were tried, such as fixing the rail ends to wooden blocks with coach-screws, but they were not satisfactory.

No damage had been done to the track on the Central railway. This was a mistake, as the bridges were quickly repaired well enough to pass motor lorries mounted on railway wheels, and the parties carrying out heavier repairs to enable engines to be used were able to move up the line with their tools and stores on hand trollies. These could be hauled across the gaps even before the light repairs were done. Thus a large number of bridges were under repair simultaneously. When it is remembered that animal transport was impossible, and roads fit for motors few and far between, the advantage of having even hand trolly transport available will be realised.

Attempts had been made to destroy most of the bridges. Some five metre reinforced concrete culverts had suffered no damage from the explosions, and generally small stone arches had not suffered as much as steel bridges. Dynamite was the explosive used, and judging by the number of unexploded cartridges found among the debris, it must have deteriorated in the bad climate. Abutments were attacked by removing the squared face stones in three or four places, and hollowing out chambers in the softer rubble backing. Plate girders had both flanges and the web cut at one end. Trusses had both top and bottom booms cut. In many cases rolling stock had been run into the gap ; and in one case an engine was put on a bridge before it was brought down. Where rivers were crossed rolling stock and old iron of every description were thrown in above and below the wreck.

Repair methods varied. Rail girders were largely used. The rule of thumb which allows one rail, of the same dimension as the running rail, per foot of span under each running rail is amply safe

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up to fifteen feet span, and gives a large margin for spans of less than twelve feet. Two girders each of four 85 lb rails carried small metre gauge engines safely over a 17 ft span. (The running rail was about 45 lbs.). Rail girders, laid under the track sleeper, strengthened stone arches when the explosion had brought down some of the rings without disturbing the formation. Supports were either trestles or crib piers. Iron sleeper cribs filled with stone ballast or rubble stood for a time; but they could not be relied on for long as the sleepers gradually flattened out.

Where diversions were impracticable rolling stock thrown into the gap increased the time required for repairs as clearing had to be done to find foundations for the cribs or trestles. On the other hand, in some cases, the girders, though cut, were held in place by the track. This considerably reduced the time taken in repair as cribs could be erected at once right up to the girder, and the latter jacked up level. Some captured 20 ton differential blocks proved very useful for lifting girders, and a jack fitted with hooks at each end was very useful for horizontal adjustment.

The most inefficient demolition met with was that of a 50-metre truss crossing a stream. One abutment had had about 2 feet blown off it, but the girder was intact. It was raised on cribs by means of large jacks and traffic passed before dark, though the repair party only arrived about one o'clock.

In one or two instances the line had been blocked by running two trains into one another. When the site of the collision is well chosen this is an excellent method. An excellent chance was missed, when five trains were found slightly damaged, in a siding four miles away from a cutting forty feet deep and half a mile long. With the tools available, it would have taken several days to clear these trains if they had been piled up in the cutting.

From a repair point of view this is one of the most awkward demolitions. Big steam cranes are not plentiful on most lines, and they are awkward things to bring up over hastily repaired track and bridges. Big bridges generally mean diversions. In one instance on the Central railway a string of awkward demolitions was cut out by making use of five miles of an old formation which had been abandoned. It was not by any means a perfect line, but its use enabled trains to be got through a good deal sooner than the other bridges could have been repaired. Consequently the first thing to look for when choosing a site for a demolition is the possibility or otherwise of a diversion. It is more important to cut the girders than to bring down the piers of a large bridge, though both should be done if there is time; trestles or cribs can be easily made, big trusses cannot. On the other hand it is essential to damage the abutment of a small bridge, otherwise the enemy can easily cross on a rail girder. Thirty 10-metre rails and a crib or small trestle will

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take a train comfortably over a thirty foot gap, and takes very little time to erect. A waggon or two pushed over the edge after the bridge has been brought down will add appreciably to the difficulty of repair.

When a bridge has been knocked about by shell fire it is well to remember that bridges generally have a factor of safety of 6 and an additional allowance for impact, which brings it up to about 10, so that trains can crawl over, after some of the members have been considerably reduced in cross section. Even if engines cannot pass, four wheeled waggons, whose axle load probably does not exceed half that of the engines, may be hauled over with a long rope.

The standard type of water tower on the German lines was a steel hemispherical tank on a lattice staging. The legs of these had been cut and the tank was usually badly damaged by the fall. In one instance where the tank was undamaged and the legs had been cut at ground level, repairs were easily made by hoisting the tank and legs upright again with a derrick, and embedding the feet in masonry. If the legs had been cut half way up, the job would have been more difficult. Usually iron tanks on sleeper cribs were erected as a temporary measure.

It sometimes happens that the source of a water supply is some way from the station. One such source was attacked and blown up which was five miles from the station. As it was only a system of filter tanks on the bank of a mountain stream, the repair was not such a serious matter as if it had been a pumping station.

The telegraph signal instruments had all been removed or destroyed by the enemy. They were replaced by telephones.

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THE BATTLE OF THE SOMME.

THE 33RD DIVISIONAL ENGINEERS AND PIONEERS AT HIGH WOOD, 15TH TO 22ND JULY, 1916.

[*From the report of the* C.R.E., 33RD DIVISION.]

1st Day, 15th July. (1) The 11th and 212th Field Companies R.E. reached the south-east corner of Mametz Wood with the 19th and 98th Infantry Brigades on the morning of the 15th, and stood by ready to move at fifteen minutes' notice, their transport being engaged in pushing up R.E. material to Bazentin-le-Petit Wood, ready to put it into work forthwith.

(2) The 222nd Field Company advanced with the 100th Infantry Brigade on the night of the 14th to consolidate the Switch Trench in High Wood after it had been taken. The capture of this trench having failed owing to uncut wire and heavy machine-gun fire, the Officer Commanding the Company, in consultation with the senior Officer on the ground, dug and wired a support point in the centre of the valley midway between High Wood and Bazentin-le-Grand, returning in the evening to bivouac south of Mametz Wood.

(3) The 18th Middlesex Regt. (Pioneers) was detailed to repair the roads and trolly line leading to Bazentin-le-Petit Wood. It left its bivouac at Bécordel at 8.45 a.m., returning at 6.45 p.m., having carried out surface repairs over a considerable length of the road. The Pioneer transport was engaged in pushing forward R.E. material to Bazentin-le-Petit Wood.

2nd day, 16th July. (1) Consequent on the withdrawal of our troops from in front of the Switch Trench and High Wood to a line in front of Bazentin-le-Petit, two sections of the 11th Fd. Company worked during the night of 15th—16th in making a strong point of the Cemetery and wiring it round. Another section made two platforms for observers in the mill situate on the line held east of the village. The 4th Section made a signal dug-out for Headquarters 19th I.B.

(2) One Section, 212th Fd. Company, and two sections 222nd Fd. Company worked during the night 15th—16th in constructing a strong point at the north end of Bazentin-le-Petit village, and another section of 212th fortified the ruined church in the centre of the village as a keep. The two remaining sections of 212th worked by day on clearing the road through the village. The two remaining sections of 222nd were kept in reserve, collecting material for repairing the trolly line and constructing dugouts for Brigade Headquarters.

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(3) The Pioneers continued road and trolly line repairs. Constant heavy traffic caused them much delay. The crossing over the German 2nd Line trenches was completed fit for heavy artillery, and the road leading down from Mametz Wood was repaired and widened. The Pioneers moved bivouac from Bécordet to Fricourt Wood.

(4) The transport of all units was engaged in pushing R.E. material to the forward dump.

3rd day, 17th July. (1) The 11th Fd. Company completed the strong point at the Cemetery, one section remaining in reserve and constructing dug-outs at Brigade Headquarter bivouac.

(2) The 212th Fd. Company worked on strong points at the north and east of Bazentin-le-Petit village, and on the church, and clearing roads through the village.

(3) The 222nd Fd. Company repaired the trolly line between Mametz and Bazentin-le-Petit Woods.

(4) No R.E. material could be got beyond Mametz Wood owing to heavy and constant shelling between Mametz and Bazentin-le-Grand Woods.

(5) Heavy rain had made the road surfaces in a very bad state. Vehicles were constantly sticking fast and blocking the roads. The congestion of traffic resulting from this was very great and the Pioneers had consequently to continue road repairs. The worst places were corduroyed with timber, and much brick from ruined buildings was transported and laid in other portions of the road.

4th day, July 18th, (1) During the day one section of the 11th Fd. Company worked on a strong point on the east side of Bazentin-le-Petit village from which the ground along the whole eastern side of the village could be enfiladed. Fire-stepped trenches and a machine-gun emplacement were constructed in spite of a heavy bombardment. During the night 18th—19th, one section helped the Royal Welch Fusiliers in making two small posts about sixty yards north of the village, and the remaining section—this company having been reduced by casualties to three sections—continued the work done during the day on the strong point on the east side.

(2) The 212th Fd. Company took over in the morning from the 97th Fd. Company of the 21st Division the works in hand in Bazentin-le-Petit Wood. Further work on these was interrupted by heavy bombardment of the wood all the afternoon.

(3) The 222nd Fd. Company continued repairs to the trolly line into Bazentin-le-Petit, and constructed new trolly frames for wheels taken from German trucks. They also brought up fifteen truck-loads of R.E. material through Mametz Wood for use on strong points in Bazentin-le-Petit Wood.

(4) The Pioneers continued repairs to road surfaces, and the

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transport of all units brought up R.E. material to the forward dumps.

5th day, 19th July. (1). The 11th Fd. Company returned in the morning from work at Bazentin-le-Petit village to their bivouac at the south-east end of Mametz Wood. The Company, less one officer and 11 O.R., left its bivouac again at 12 midnight to join the Infantry detailed for the assault on High Wood.

(2) The 212th Fd. Company left its bivouac at the south end of Mametz Wood at 8 a.m. for work on the strong points in Bazentin-le-Petit village and wood. Good progress was made on these works. After returning at 5 p.m., two sections went out again to the village and wired under heavy fire, after 200 man-loads of R.E. material had been brought up to the north of the village.

(3) The 222nd Fd. Company continued repairing the trolly line and constructing trollies.

(4) The Pioneers continued road repairs.

6th day, 20th July. (1). The 11th Fd. Company joined the 20th Royal Fusiliers north of Bazentin-le-Grand at 2.30 a.m. The company was to advance into High Wood as soon as it was taken and construct certain strong points decided upon beforehand. Each section carried tools and stores, and a Company of Pioneers was detailed to assist. Subsequently, owing to the situation in the wood, the Pioneer Company was diverted to communication trench excavation. One section of the 11th Fd. Company dug in at the rear end of the wood, pending orders from the officer commanding, Captain Sim, who went into the wood to reconnoitre. Under the heavy shell-fire the officer in charge of the section and the N.C.O. were wounded. A lance-corporal remained in charge of the section. At 9.0 a.m. Captain Sim and the lance-corporal were also wounded, there being then only eleven men left of the section. These joined one of the other two sections. Another section moved up to a small trench on the south-west face of the wood and waited in it for the enemy at the north end of the wood to be pushed out, to enable them to get to the tasks allotted them. As at 11 a.m. the enemy with a machine-gun were still in the north of the wood, they proceeded to construct a fire trench projecting out from the west face to enfilade the west corner of the wood, and this was done without help from the Infantry. During the afternoon the enemy was pushed out of the wood to the extreme north corner by the Royal Welch Fusiliers. The digging of a trench was then taken up with the Infantry at 7.45 p.m., down a clearing about 100 yards from the north-west face of the wood. At 10.30 p.m. the portion of this trench was about four feet deep, and traversed, when the infantry fell back under a heavy counter-attack out of the trench which was vacated and lost. The remaining section of this company after entering the wood moved up the south-east face and commenced under heavy shell-fire a strong

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point projecting out from the north-east face. The officer in charge was wounded and the sergeant killed. The section completed and wired the work under a corporal by 9.0 p.m, when the section was called on by an Infantry Officer to man the north-east face of the wood, where it dug itself in in rifle pits, and remained until ordered to retire to the support trench.

On receipt of information at Brigade Headquarters at about 9.30 a.m. that the O.C. of the Company was wounded, Captain Pressey, the next in command, at once proceeded to the wood with the 11 men left at the bivouac, and remained there throughout the day until 12.15 a.m. when firing having quieted down and reliefs having arrived he returned to bivouac.

(2) 3 Sections of the 212th Fd. Company left their bivouac at Mametz Wood at 7.30 p.m. under orders to relieve the 11th Fd. Company in High Wood. They reached High Wood at 9 p.m. Owing to the Infantry party detailed to carry up R.E. material for them having been diverted to other duties, and the Infantry in the wood having retired from the line the Company was ordered to consolidate during the night, no work was done.

(3) Two sections of the 222nd Fd. Company proceeded with the 11th to the point of assembly north of Bazentin-le-Grand. Definite tasks were allotted to them. They remained at the assembly point until the O.C. 11th Fd. Company sent word for them to come up. By then heavy barrage fire had been opened by the enemy, and in moving up the officer in charge was killed and a number of men wounded. The two other sections went out at 8 p.m. and dug a support point south of the road leading from Bazentin-le-Petit to High Wood.

(4) The Pioneers started work after the assault on High Wood excavating a communication trench to the wood. The enemy's heavy barrage fire caused considerable delay in the progress of this work.

7th day, 21st July. (1) The 11th Fd. Company remained in bivouac, having suffered heavy casualties and lost all their officers but one in High Wood.

(2) The 212th Fd. Company was throughout the day in High Wood, where they assisted in trench excavation and brought up 120 man-loads of R.E. material for use in consolidation. They withdrew at 7.30 p.m., the Division being under relief.

(3) The 222nd Fd. Company were employed through the day on the strong points started by the 7th Division in Bazentin-le-Grand. Two strong points at the cross roads north of the wood, and one east of the wood were completed, with machine-gun emplacements and wiring, and work was done on the keep in the centre of the village.

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(4) The Pioneers continued work on the communication trench leading to High Wood.

The Division was relieved on the night 21st—22nd July.

Casualties.

	Officers.		Other Ranks.		
	K.	W.	K.	W.	M.
11th Fd. Company ...	0	4	11	53	3
212th ,, ...	0	2	1	19	0
222nd ,, ...	2	0	0	24	0
Total ...	2	6	12	96	3

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HIGH SPEED WIRELESS INSTALLATION.

WHEN, probably in the not very distant future, it has become the normal practice to receive wireless messages much in the same way as ordinary line telegraph messages are nowadays received, that is in the form of paper strip inked in morse code or printed in Roman character, or when it has also become quite customary to transfer a wireless message automatically and immediately to land line instruments, and to perform these operations at the same speeds as those now possible in line telegraphy, it will be interesting to have it on record that some of the pioneer work in these directions has been carried out by officers of the Royal Engineers and other workers attached to them, impelled in this direction by the mass of wireless traffic imposed on the Signals of a modern army when open warfare is resorted to on a large scale, and line communication becomes difficult to instal.

For some time experiments in this direction have been in progress at the Signals Experimental Establishment on Woolwich Common, and it is now found to be quite practicable to handle traffic by wireless telegraphy at speeds of one hundred words per minute, using the standard Post Office type of Wheatstone transmitter with punched tape for transmission, and the standard Wheatstone inker for reception. It is also obvious that a message which can be made to operate an inker can also be employed to actuate a printer receiver of the Creed or other well-known type, or to operate a line transmitter and so translate the wireless message direct on to land lines.

The first practical tests of this method were carried out between Woolwich and Bedford in July 1919, when a speed of 62 words a minute was reached.

After other trials with gradually improved instruments a prolonged test was made between Woolwich and Weymouth using quite moderate power. The apparatus was not tried at much over one hundred words per minute, but perfect records were obtained at the following speeds:—2017 words in 30 minutes, 901 words in 8 minutes and 379 words in 4 minutes.

Those accustomed to handling wireless traffic will readily realise the value of being able thus to receive at speed on a standard inker, and will appreciate the value of this experimental work. It may be added that there would not appear to be very much difficulty from the electrical point of view in attaining very much higher speeds. The only limit is that set by the exigencies of mechanical design.

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THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914—1919.

(*Continued*).

CHAPTER IV.

TEMPORARY BRIDGES.

(*Reference* MAP *following* PLATE XXIV., *page* 216, R.E.J. *November*, 1919)

Introduction.—General types of Bridges.—Pontoon and Trestle Equipment.—Haute Deule Canal.—Canal du Nord.—Hasty Bridges constructed by one Corps.—Work of the R.E. of another Division in crossing the Canal du Nord.—The Escaut Canal and River.—Tank Crossings.—River Selle.—Tank Bridge over the River Selle.

1. INTRODUCTION.

During the final advance from August to November 1918, an enormous amount of hasty bridge work was thrown upon the Divisional Royal Engineer units.

Every successive stage of the enemy's retreat finished by his taking up a position behind a water obstacle after destroying all existing crossings. The forcing of a passage of the waterway would therefore always become the first stage of the succeeding battle.

In the course of these three months many hundreds,—probably thousands,—of light bridges for Infantry and First Line Transport were made by Divisional Troops, in addition to many crossings for Tanks and Heavy Artillery.

A full account of this work is manifestly impossible; all that will be attempted here is to give a description of some typical operations, and types of Bridges constructed.

The names of units and formations concerned are purposely omitted.

2. GENERAL TYPES OF BRIDGES.

Foot bridges of every variety were constructed, the type generally depending on material that happened to be most easily obtained at the moment.

Floating piers were made of cork, oil tins, captured German floats etc, in order to make hasty single file bridges for Infantry. *Plate* XX gives details of the usual type of cork pier, and *Plate* XXI a

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petrol tin pier. The standard pontoon equipment was extensively used for passing over field guns, and first line transport.

On one river there were actually 30 pontoon bridges in position simultaneously on the front of one single British Army.

The cork floats were probably the most satisfactory of all for Infantry troops, as they were found to be absolutely impervious to shrapnel or splinters.

The supply of cork was never equal to the demand, and is an interesting example of the difficulty in foreseeing requirements. Cork floats had been experimented with before the advance and found sufficiently satisfactory to justify a considerable number being made up at the Base. Their use had been explained to all Armies, and Chief Engineers were asked in the early summer of 1918 to give an estimate of the amount they were likely to require during the rest of the year. The total estimate amounted to under 50 tons,—100 tons were actually ordered and made up into floats, and the whole of this was issued and used during the first few weeks of the advance. Further supplies had to come from overseas, and owing to shipping difficulties could not be obtained in time to be of much use.

So valuable were these floats considered by many units that, in spite of their weight after being any length of time in the water, they were frequently lifted and carried forward for re-use. Floats made of oil tins were lighter to carry, but were easily punctured and sunk. *Photograph* LIII. shows a bridge of petrol tins in actual use at Landrecies.

Pontoons are also liable to be damaged by shell fire, but on the whole they suffered remarkably little, and, provided that spare boats and equipment were at hand, damage could be very quickly made good.

Light pile foot bridges were used with good effect by some units, and were quickly and easily constructed when the river bottom was suitable.

A device for rendering pile bridges unserviceable in case of hostile attack is illustrated, and was employed by one Division. Though never actually tested in an attack, its efficiency was demonstrated by bathers catching hold inadvertently and drawing the pins, which were kept well greased. (*Plate* XXII.).

Pontoon and Trestle Equipment. During periods of trench warfare Field Company bridging equipment had been generally stacked under Divisional arrangements in order to avoid frequent moves of unnecessary loads, and also to set free the bridging wagons for carriage of other R. E. Stores.

By the beginning of 1918 nearly every Army had gone as far as to form central Depots where the Bridging equipment of all Divisions in the Army could be parked and looked after. These Depots were

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generally at the headquarters of a Pontoon Park. When a Division left the Army, it would collect its equipment from the Pontoon Park, or in certain cases the Park actually delivered the equipment to the Division at its new location.

Difficulties arose during the operations when Divisional reliefs were frequent and rapid, and Divisions would sometimes arrive with no bridging equipment in the area of an Army that was on the point of carrying out an attack.

In cases of emergency, Divisional equipment could always be made good from an Army Pontoon Park, and the Pontoon Park would then demand an equivalent amount from the Base; but the drain on the Base reserves became so great that this system could not have continued indefinitely, and new equipment was not normally issuable from the Base except in replacement of an equal amount certified to be destroyed or beyond repair.

3. Haute Deule Canal.

The following is an account of work carried out by the Field Companies of one Division.

The preliminary scheme was to cross the canal on a 2-Brigade front, each Brigade to have 4 foot bridges ready prepared, as near a possible to the outpost line, which could be easily carried to the canal, and fixed in position.

In addition, under orders from the Corps, 2 Pontoon Bridges were to be thrown across the canal as soon as possible after the Infantry had crossed, and one of these bridges was to be of heavy type to carry motor lorries. Additional pontoons for these bridges were specially allotted to the Division.

Sites for the bridges were selected by means of air photographs supplemented by information from civilians.

Two Field Companies were employed in the work of getting the Infantry across the canal, and each company made four foot bridges, using petrol tin or wood floats. *Plate* XXIII. gives details of a wood float Bridge.

The petrol tin floats took slightly longer to make, but were found much easier to carry to the canal.

Immediately the Infantry had made good the further bank, each company commenced a medium pontoon bridge. The previously selected sites were found entirely suitable, and very little work was needed on approaches. Both pontoon bridges were later converted to heavy type. This work was entirely done by night in bad weather. Each bridge took between 50 and 60 men, ten to eleven hours actual work.

On the same canal an interesting example of a heavy trestle bridge

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was made by a neighbouring Division to carry loaded lorries. This bridge did not form part of the original Divisional scheme, and had to be designed and built at very short notice.

A dump of heavy bridging material consisting of rolled steel joists and timber of large section had been formed by the Division from locally salved material, and the bridge was designed to make use of this material.

The first reconnaisance was made at midday on the 16th. September. Work was commenced at 3 p.m. on the following day, and was completed and the bridge opened to traffic at 11 p.m. on the 18th. Two sections of a Field Company were employed with a Company of Pioneers to make up approach roads. Total span of the bridge was 112′, and was carried on 7 trestles. Road bearers consisted partly of R.S.J's, and partly of round timber.

Details of this bridge are given on *Plate* XXIV.

4. CANAL-DU-NORD. HASTY BRIDGES CONSTRUCTED BY ONE CORPS.

Preparations were difficult owing to the nature of the ground, and the fact that the approaches to the canal were subject to very heavy machine gun fire.

Information was obtained from maps, plans, aerial photographs, reconnaissance by R.E. Officers on the ground, and also from the air. The canal averaged 100′ in width with banks varying up to 15′ in height, and depth of water in the wet portions of the canal over 8′.

On about half the front of attack the ground was marshy. The ground on both sides sloped towards the canal.

The scheme provided for seven Infantry foot bridges, and ten crossings for guns and first line transport, five of which were designed to be developed immediately for heavy traffic.

'A' Crossing, (Dry). At zero hour a party was sent out to keep touch with the Infantry, and as soon as the Infantry had cleared the canal, the company started their task, arriving on the work at zero plus 40 minutes. The approaches were only foot tracks, and these had to be first improved. Craters had been blown in the roadway in the centre of each embankment, and the banks were mined at the edge of each crater. One of these mines was exploded by a tank, which became disabled and blocked the passage. Another tank was called upon, and the obstruction quickly removed. The other mines were exploded by guncotton.

The crossing was ready for one-way horse traffic at zero plus 3 hours and 40 minutes.

'B' Crossing, (Dry). A good earth road led up to and from the crossing. A very large crater was blown in the roadway in the centre

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of the canal crossing, and a smaller one in the west embankment. The large crater was filled with boards, brick, etc., and earth and chalk from the embankment.

This crossing was ready for one-way traffic at zero plus 1 hour and 30 minutes, and two-way traffic at zero plus 2 hours, and for two-way lorry traffic at zero plus 3 hours.

'C' Crossing, (Dry). A party consisting of 2 Officers and 37 men R.E. arrived at site at zero plus 2 hours and 10 minutes, after being heavily shelled en route.

A very large mine had been blown by the enemy. The crater was filled in with timber and rock, and 2 tanks were put over the crossing to crush in the fill near the bottom.

By zero plus 2 hours and 40 minutes a crossing had been made good enough for the passage of Field Artillery.

Work was continued for the remainder of the day, and a 20' roadway constructed with earth, steel rails, and timber cribbing.

A one-way lorry plank road was completed across the canal by zero plus 8 hours and 25 minutes.

On the second day the cribbing was completed, reinforced and braced. The planking was doubled to make it suitable for two-way traffic, and approaches strengthened.

'D' Crossing, (Dry). Work was started at zero plus 1 hour, and was ready for traffic by zero plus 3 hours and 30 minutes—this work consisted of filling in a road crater 30' diameter and 10' deep on the west bank of the canal.

A temporary diversion was made around the road to allow traffic to pass while the crater was being filled in. The first gun actually went over this crossing at zero plus 3 hours 20 minutes. The crossing was ready for two-way traffic at zero plus 12 hours.

'E' Crossing, (Wet).—Work on this crossing was held up by hostile machine gun fire and shrapnel, and the Officer in charge of the party was wounded.

This crossing consisted of a combined pontoon and trestle bridge of 90' span. Ramps had to be cut through the bank on each side about 20' long. Work was commenced at zero plus 13 hours.

'F' Crossing, (Wet). This crossing consisted of a 60' span pontoon and trestle bridge over the canal, and two 30' trestle bridges over a stream on the east side of the canal.

Work was commenced at zero plus 6 hours and 40 minutes, and completed at zero plus 8 hours and 10 minutes, in spite of enemy machine gun fire.

'G' Crossing. A bridge of 60' span.—Great difficulty was experienced in launching the trestles in the muddy bottom of the canal, which was about 2' to 3' deep in water, but was not suitable for pontooning owing to the number of old piles sticking up in the

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water. Work could not be begun till zero plus 9 hours 40 minutes, on account of enemy machine gunners holding out in the swamp east of the canal at this point.

The bridge was finished at zero plus 10 hours 50 minutes.

Between 'E' and 'G' crossings half a company R.E., and half a company of Pioneers had advanced with the Infantry to make hasty foot bridges. The wagons carrying the cork floats came under heavy Machine Gun fire when within 200 yards of the canal bank. Several horses and drivers were wounded, and the teams were unhooked, and wagons pushed down by hand.

Six Infantry foot bridges were thrown across the canal. These were of two kinds—cork pier Bridges, and a 16′ span light trestle Bridge. The cork piers made a firmer bridge when erected, but took rather longer to make as the cork floats were heavy and difficult to carry. The trestle bridge was made of light 16′ span foot bridges resting on light trestles. This was very quickly erected and made a good bridge.

'H' Crossing, (Wet). Trestle and pontoon bridge consisting of 2 pontoons and 3 trestles, 90′ span.

'K' Crossing, (Wet). One Company R.E. constructed a Weldon trestle bridge alongside a demolished culvert, and replaced the culvert by an 18′ span rolled steel joist bridge. These were on the west side of the canal. Work was commenced within half an hour of the attacking Infantry passing this point.

The trestle bridge was completed in an hour and 10 minutes, and the steel bridge was ready for lorry traffic an hour and a quarter later. A second R. S. J. bridge was constructed the following morning to provide for two-way lorry traffic.

As soon as the Weldon trestle bridge had been completed, half the company went forward to the canal, and constructed a medium pontoon bridge 120′ long. This was open to traffic less than 3 hours after work on the trestle bridge had been completed.

A second Field Company constructed a D. type heavy pontoon bridge for lorry traffic on the other side of the demolished road bridge. This bridge was 120′ long, and considerable work was also required on the approach ramps. The whole job was completed in about $5\frac{1}{2}$ hours' work.

Work of the R.E. of another Division in Crossing the Canal-Du-Nord. The Infantry attack was made by one Brigade, and two Field Companies had been detailed to carry out bridging across the canal and a stream to the East of it.

The Infantry attack was held by heavy machine gun fire from woods on the west of the canal. Both Field Companies, however,

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extended and worked their way round and through these woods and succeeded in capturing the canal bank together with a number of prisoners.

One Company reached the canal at 11.30 a.m. and the other at 12.45, both being well ahead of the leading Infantry.

The first company completed a cork raft and plank foot bridge across the canal and marsh by 12 midday, and an Infantry foot bridge across the river by 1.45.

The second Company found the canal no obstacle to foot traffic, and completed an Infantry bridge across the river by 2.5 p.m.

The Infantry did not actually advance beyond these crossings until 5 p.m. and it was impossible to bring up pontoon wagons to the canal till after dark.

A medium pontoon bridge was commenced after midnight by the third Field Company, with an Infantry working party cutting through the banks to make approach ramps.

The work was all completed by 5 a.m.

On the front of another Army the Canal formed the dividing line between the British and German troops.

A particularly fine bit of work was done by a Field Company during the nights preceding the attack in the construction of a trestle bridge for Artillery and first line transport across the canal within a short distance of the enemy.

A section of the canal was taken at day-break, and gave the following measurements—width between towpaths 79′ 6″—width of bed of canal (dry bottom, brickwork) 40′ 6″—depth of Canal below towpath 15′ 6″.

The Field Company was organised in teams, each team being responsible for the construction of 1 trestle plus 1 bay.

As many fastenings as possible were designed to be by means of bolts, and great care was taken that these should fit easily, and only require to be pushed through.

Road bearers were notched to fit over transoms, and blocks were also nailed on transoms at the required distances, so as to avoid having to make any measurements on the night of operations. The material was carried to within 300 yards of the site on pontoon wagons, and then carried by hand along the canal, and distributed under cover.

Two nights before the advance sites were cleared out for the 2 shore trestles, and the trestles were placed in position and left leaning against the wall of the excavation. Shore transoms were also fixed into position, all being covered with scraps of canvas etc.

On the following night two of the larger trestles were assembled and left leaning against the brick walls of the canal.

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On the night before the advance the Company, organised in their trestle teams, started work about 8.15 p.m. and completed the bridge by 1.15 a.m., roughly four hours before zero. In the original scheme it was ordered to be completed within four hours after zero.

Although the enemy line was only 500 yards away, work went on without any interruption, owing to the very complete previous arrangements, and the complete silence that was maintained every night.

This fine piece of work enabled the Divisional Artillery to follow and come into action immediately behind the attacking Infantry, and had great influence on the success of the operations.

Photograph LIV. shows a crib and trestle bridge for lorries constructed by a Field Company, and *Photograph* LV. shows a trestle bridge alongside a typical ramp for tanks.

5. THE ESCAUT CANAL AND RIVER.

The following is an account of the work of one Company in assisting an Infantry Brigade to force the passage of the canal.

The work consisted of :—

(1). Reconnaissances and preparations to throw floating bridges (cork) over the canal, and to furnish rafts and boats to enable the Infantry to cross when opportunity permitted.

(2). Actual putting over of 1 cork float bridge, and furnishing of rafts ; making passage over debris of old lock and bridge.

(3). Repairs of 2 destroyed foot bridges, and salvage of material.

Reconnaissances were made on the front of both attacking battalions, and the necessary material was brought up by lorry and carrying parties.

On the left battalion front the bridge was constructed in the courtyard of a mill with gates facing on the canal bank covered from view, some measure of protection being thus secured. Water in the canal was high, and the approaches ideal. On the right battalion front the approach and carrying were very difficult. A spot was selected, and preparations made to bridge if it should become possible.

The Piers of the bridge (cork) were also fitted with an extra bale of cork to give sufficient buoyancy to allow their use as rafts if this should prove more feasible than the completion of the bridge. Paddles, etc., were held in readiness. Another alternative was the possibility of crossing on the debris of a destroyed bridge.

At zero on the day of attack the bridge on the left Battalion front was successfully put across.

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The gates were flung open, and the bridge carried bodily to the water's edge and pushed over. The carrying party were actually the first Infantry to cross. During the operations the bridge broke, but was held together by hand until the first troops were over. No delay was caused, and it was afterwards repaired.

On this battalion front 6 cork rafts, each made from 3 bales of cork, were also used to ferry men across.

On the right battalion front the leading troops of Infantry and Sappers found the debris of the old bridge and lock passable—no new bridge was constructed, but the old crossing was improved.

Tank crossings.—Two tank crossings were constructed by one Field Company over the river and canal, each consisting of three 20′ spans, the standard 22′ rolled steel joist tank bridges being supplied direct from the Army Bridging Depot. In each case the canal crossing was effected by one span across the lock.

Bridges for the first crossing did not arrive until after dark, and were only brought up by lorry with the greatest difficulty and exertion. Work was commenced at 9.30 p.m. and went on continuously until 7 a.m. the following morning, when all three bridges were completed.

One section R.E. worked on each bridge, and the ramps were made by two platoons of Pioneers.

Considerable shelling went on all night, and the company had 12 casualties at the very beginning of the work, which made them short-handed.

One bridge of the second series arrived at 10 o'clock the following night, and this was unloaded and erected by 1 a.m. in spite of continual shell fire. The other two bridges arrived the following afternoon, and were completed with ramps by midnight—in this case the lorries could not approach the site, and a long carry was required, which took much extra time.

The following extracts from the War Diary of a C.R.E. Division describe the bridging work done by the Field Companies for the crossing of the canal and river :—

September 28th.—Headquarters R.E. and Field Companies moved to 'F'.—All pontoon equipment was moved to 'F', and during the night Officers went forward to reconnoitre forward area, and river and canal.

September 29th.—Early in the morning the advance section of 'A' Field Company constructed a foot bridge over the canal from old German floats found lying about, and passed a battalion of Infantry over.

Officers of the three Field Companies made detailed reconnaissances of the canal and river.

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Another foot bridge was put across the canal by 'A' Field Company.

At 4 p.m. a pontoon bridge to take transport was put across the canal by the 'B' Field Company.

The 'C' Field Company repaired three existing Bridges across the river and canal, and also put a medium pontoon bridge over the canal.

September 30th.—'A' Field Company put across another foot bridge, and repairs to an old German bridge were carried out, and this bridge made passable for both transport and 4·5 howitzers.

'C' Field Company reconstructed existing light bridge to take 60 pounders.

'B' Field Company constructed a new trestle bridge over the canal, and a trestle bridge over the river was strengthened to take 60 pounders.

October 1st. and 2nd.—'A' Field Company commenced the construction of a trestle bridge to take lorries over the river—other companies were employed on the maintenance and strengthening of existing bridges, which was necessary owing to the heavy shelling. Approaches to bridges were improved.

October 3rd.—Trestle bridge was completed by 'A' Field Company. (*Photograph* LVI.).

'B' Field Company commenced two trestle Bridges over the river, and a pontoon bridge over the canal.

All three bridges were completed by 9.30 a.m.

October 4th and 5th.—Maintenance of existing bridges, and of plank road leading to lorry bridge.

October 6th.—'B' Field Company commenced preparation for the construction of a 60′ steel girder portable road bridge over the River.

The other two companies continued maintenance work, and the 'C' Field Company put another pontoon bridge across the canal.

October 7th.—Owing to the advance being continued, work on the girder bridge had to be suspended. Companies concentrated on the work of strengthening existing Bridges to take additional transport.

October 8th.—During the night 7th/8th it was reported that the water level in the canal was falling. Reconnaissances were made and this was found to be the case. Urgent messages were sent out to the companies instructing them immediately to replace all existing pontoon bridges by trestle bridges.

'C' Field Company replaced two pontoon bridges over the canal with trestles, and 'A' Field Company erected a new trestle

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bridge over the canal. These bridges were all completed by 5 p.m. and very little inconvenience was caused to traffic.

October 9th.—Canal bed repaired where culvert had been hit by shell, thus lowering water level.

'A' Field Company commenced the construction of a heavy trestle bridge to take lorries, and 'B' Field Company continued the construction of the steel girder bridge.

'C' Field Company concentrated on maintenance.

October 10th.—Work continued as on 9th.

October 11th.—Heavy trestle bridge and steel girderbridge both completed.

Practically all bridges were constructed and repaired under heavy enemy shell fire. Timber had in many cases to be salved from old bridges, and a great deal of work could only be done by night.

On the front of another Division where the attack was made by one Brigade, arrangements were made for ferrying the Infantry across the river in 25 improvised canvas covered boats, simultaneously with the construction of 4 floating foot bridges.

The foot bridges were designed to carry Infantry in single file at 3 yards interval, and were composed of 10′ duck-boards on floating piers of German torpedo floats—the average width of the river was 100′.

Two Field Companies were told off for the work, two sections of each company being employed in ferrying, and the other sections each making a foot bridge. These latter sections each had a working party of one platoon of Pioneers attached to them.

The boats were most successful,and it was found possible by means of 12 boats to transport an entire battalion across the River before the foot bridges were ready.

Immediately the crossings had been made good, work was commenced on a timber trestle bridge with R.S.J's as road bearers to carry 17 ton axle load. Schemes for all this work had been very carefully prepared beforehand, and no hitch occurred in the actual execution.

Another Division ferried the leading Infantry across on four different types of raft, which are illustrated.

Type A. This was constructed of an ordinary bivouac sheet 13′ × 10′ wrapped round a wooden crate outside of which facines made of reeds and straw were fixed to provide extra buoyancy. The chief points of this type were stability, and absence of noise when being propelled through the water.

The sheets are apt to become waterlogged, but are sufficiently waterproof to serve for a hurried crossing up to 8 or 10 hours immer-

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sion. This raft can be lifted and carried by 4 Sappers. (*Plate* XXV.).

Type B. This is an ordinary German pattern formed by 2 piers of 2 floats each, and is capable of carrying 3 fully armed men. It has the advantage of low freeboard and comparative absence of noise. (*Plate* XXVI.).

Type C. Explains itself. It is fairly rigid but is comparatively very heavy. (*Plate* XXVII.).

Type D. Is more unstable than Type C. and there was doubt as to its suitability—it was, however, used quite successfully on one sub-sector. The propulsion was by means of a tow-rope, and not by paddles. (*Plate* XXVIII.).

Plates XXIX. and XXX. give details of two bridges erected by Canadian Divisional Engineers, and *Photograph* LVII. shows a R.S.J. and trestle bridge to carry tanks built by a Field Company of another Division.

6. River Selle.

The crossing of this river involved probably more arduous work for the Divisional R.E. than that of any other.

The following extracts from the Report of an Army Chief Engineer give a good idea of what was done :—

"During the period October 10th to 19th foot bridges of varied type, cork float, light trestles, duck-board and petrol tin bridges were erected at intervals along the whole Army front. All pontoon equipment was brought up, and numerous crossings for Infantry made.

These bridges were mostly protected from enemy fire by the height of the river banks, but the pontoons proved very vulnerable during the journey up to the line.

At one time over 30 pontoon bridges were in position on the Army front ; a wonderful total if it is considered that the river was practically the dividing line between the two Armies. Work was often done within 50 yards of the enemy, who kept up a constant machine gun and artillery fire on the river. Heavy casualties were often inflicted on Field Companies engaged, but the work was invaluable.

Preparations were now made to cross the Selle river on the 20th October.

It was essential for the success of the attack that the enemy should remain in ignorance of our intentions—it was decided therefore to postpone all work until the night of the 19th/20th October. During the preceding night bridges of all types were brought up and concealed near the sites, and the work of construction commenced immediately darkness fell on the night of 19th October.

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On all Corps fronts the plans adopted were similar. It was decided to increase the number of foot bridges until a minimum of 1 per 100 yards of front was in position.

Light trestle bridges were to be erected in various places to allow the passage of field guns, and heavy bridges of the R. S. J. Type were to be placed in position as soon as the attack was seen to be successful.

On the " W " Corps front many foot bridges and pontoon bridges had been placed in position by the R.E. of two Divisions. On the night of the 19/20th October these bridges were increased in number until there were 20 on the Corps front.

During the night R.E. of one Division erected Weldon trestle bridges over the river at two points to take field guns.

These bridges were successfully used by the attacking forces, and the R.E. were able to commence the erection of heavy bridges on the morning of the 20th.

On the " X " Corps front the scheme for the attack of one Division necessitated the construction of foot bridges above and below the town of Solesmes. Surprise was essential—there was to be no preliminary bombardment, and the construction of bridges was to be put off until the last moment. Information was scanty owing to the fact that the enemy outposts were so near the chosen bridge sites.

It was decided to erect 8 foot bridges north of the Town, and 4 to the south. Later 2 pontoon bridges were to be erected over the river to carry field guns. The material for these bridges was brought up and concealed near the sites.

The erection of the foot bridges commenced soon after midnight on the 19th. All bridges were completed before zero hour, and the operations were entirely successful. Slight floods were caused by debris damming the river, but the foot bridges were lengthened and the difficulty overcome.

To ensure that the position of the bridges was obvious to the Infantry, the bridges were marked with tapes and small red lights placed in position.

On the 21st October trestle bridges for horse transport were erected over the river at four points.

On the 23rd October R.S.J. spans were erected over the river at Solesmes.

On the front of another Division foot bridges were made of various types, and work began at 10 p.m. on the 19th. The heavy rains rendered work difficult, but all the bridges were thrown across successfully without alarming the enemy.

Great credit was due to the good discipline of the men, who preserved absolute silence, and to the avoidance of any splash in

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placing the piers. The organisation worked smoothly, and from midnight onwards one bridge was brought down to the river every 10 minutes on each brigade front.

Two Field Companies then undertook the construction of 2 pontoon and trestle bridges at zero minus 1 hour.

The construction of a heavy tank bridge was undertaken by the third Field Company—it was erected under considerable difficulties, but in spite of heavy gas shelling and rain, the work was completed on the same day.

On the " Y " Corps front the R.E. of one Division had during the week preceding the attack placed many foot bridges and pontoon Bridges in position.

On the night before the attack 2 pontoon bridges and 4 light foot bridges were erected, in spite of considerable shelling and machine gun fire which caused many casualties, and a gas concentration, which necessitated the use of respirators for some hours.

On the day of attack bridging operations were divided between two fresh Divisions.

The approaches to the river are very difficult to traverse during the night on account of their openness. To obviate this tapes were laid down with notice boards to each bridge-head, and lamps lit which gave a red light to the rear.

On the day of attack the bridges were successfuly used by the Infantry, and R.E. of both Divisions were able to commence the erection of other types of bridges.

In addition to 16 foot bridges—2 Pontoon bridges, 2 trestle bridges for horse transport, and 1 R. S. J. tank bridge were erected.

On the " Z " Corps front the procedure was slightly different.

As with the other Corps, foot bridges and pontoon bridges had been erected along the whole front usually under very difficult circumstances, but assisted by the fact that the Infantry had established themselves slightly to the East of the river.

Bridging operations were shared by two Divisions.

On the night of 19th October a heavy tank bridge was completed across the river Selle North of Neuvilly in 1 hour, 45 minutes, the material having been previously brought to the site and concealed.

On the 17th and 18th October field Companies of one Division erected 24 foot bridges, the work being of an extremely difficult nature owing to the proximity of the enemy, and the very light nights. Tank bridges were erected by Field Companies of the same Division.

One Field Company completed their bridging on the night 16th/17th, working breast deep in water for several hours under

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shell and machine gun fire, with the enemy's flares falling within 20 yards of the site.

Another Field Company erected a tank crossing consisting of sleepers threaded on iron rods, the work being completed on the night 19th/20th: being under the surface of the water it was not discovered by the enemy.

On the morning of the attack these bridges were successfully used by tanks, and close co-operation with the attacking Infantry greatly assisted the advance.

Two of these crossings were afterwards destroyed by enemy fire.

Half an hour after zero on the 20th, R.E. of the other Division erected trestle bridges for H.T. north and south of Neuvilly.

Later in the day heavy bridges were constructed in Neuvilly, one for Tanks and one for 12-ton axle load.

Both bridges were completed by the 22nd of October, in spite of direct hits while under construction.

One Field Company erected 2 trestle bridges for H.T. and one medium pontoon bridge, in the course of which 50 per cent of the Company became casualties."

The following is an extract from the report by the C.R.E. of one of the Divisions engaged, which gives in greater detail an account of work carried out:—

o o o o

"Reconnaissances were carried out on the night of the 17th, and the width of the river at water level estimated to be about 25', depth 3' to 4', banks very steep 6' to 10' high, and quite unclimbable by Infantry in fighting order.

The bed of the river had 1' to 2' of mud. It was decided that the northern set of bridges should consist of 6 light trestle bridges, and 2 cork bridges carrying Infantry in single file.

In addition, in case the bridges should fail, 4 wire netting mats were to be laid across the river to allow men to walk through the water over the mud.

Ropes were to be laid across the river at these crossing places from top to top of bank, to enable men to pull themselves up the steep banks.

Scaling ladders 10' high were also given to the Infantry for the same purpose.

Owing to the necessity for absolute silence throughout the operations, and the steepness and height of the banks, petrol tin bridges, light pontoon bridges, and barrels were ruled out.

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The night of the 18th/19th was used for carrying up material, and setting it out into bridges.

The carrying party of the Pioneer Battalion was organised in such a way that each party knew exactly what it had to do.

The party was attached to a Field Company for two days before the operation, and was given all possible instruction in handling the material, which had to be carried about 700 yards from the wagons.

On the night of the 19th/20th, zero hour having been fixed for 2 a.m. on the 20th, the erection of the bridges was started at 1.30, and completed at or before zero in every case.

A single cork float bridge was completed half an hour before zero to enable a Company of Infantry to pass over as covering party—the company lay under the far bank of the river. The Infantry passed over the bridges without a check of any kind, and the operation was completely successful.

The limits for the southern set of bridges had been decided by reconnaissance on the night of the 17th; a second reconnaissance on the night of the 18th showed that the river had risen several feet owing to the enemy having dammed it between the northern and southern bridging places, and the sites for the Southern bridges had to be moved.

It was decided to make 2 petrol tin, and 2 cork float bridges on the night of the 19th, all the material having been carried up in the same way as for the northern bridges to the site of the work.

Bridging was started at 11 p.m. on the 19th. It was found that the river had risen still further, and the bridges were not long enough to span it—their number was accordingly reduced to 3, and an existing foot bridge patched up to serve as a fourth—the operation was quite successful, and the Infantry passed over without a check in due time.

The light trestles which were used were made out of hexagonal 16′ signal service telegraph poles.

They were 4 legged, with transoms 7′ 6″ above foot of legs; the legs were splayed out 2′ 6″, each pair of legs 4′ 6″ apart.

Angle iron pickets were used as ledgers in order to sink the trestles—all lashings were of wire.

Trestles were stiffly cross braced and made up complete with the lashing fixed to the transoms before leaving camp.

The footways for the trestle bridges consisted of 2—15′ duckboards 2′ wide, runners 3″ × 3″, slats 3″ × 1″ placed $1\frac{1}{2}$″ apart. The duckboards thus formed were stiffly trussed underneath with heavy telegraph wire windlassed tight. Each trestle was carried out into midstream by 2 men wading, and stuck into the mud without difficulty.

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The cork bridges were formed of 3 piers of cork at 7′ centres, and the centre pier was anchored back to each bank.

The wire netting mats were made of German wire netting 1 metre wide with slats 1½″ × 1″ fastened on the top side of the wire 18″ apart. These were fixed down with screw pickets at the shore end, and rolled across the bed of the river by a man wading along and shoving the roll in front of him with his foot, and picketed down on the far bank. Slung ropes were placed alongside each mat to guide men over, and help them down and up the banks. These mats were not used owing to the success of the bridges.

Petrol tin floats in pairs were made with 2 frames each holding 24 tins spaced at 9″ centres, tins being encased in a crate of rabbit wire, and wedged tightly in a 3″ × 3″ timber framing.

At the southern site mauls muffled with sandbags could be used to drive pickets, but at the Northern site screw pickets had to be used.

Some specially strong kite balloon screw anchorage pickets were obtained, and found very successful on the northern site.

Absolute silence was necessary as the nearest enemy post was found to be only 50 yards off.

The approaches to the bridges were marked with tapes.

The river ends of the approaches were marked with number boards painted white on black 1′ square, the other ends were marked with petrol tins punched with corresponding numbers with candles in them. These candles were quickly put out by shelling, but the moon gave sufficient light for the tapes to be found.

Organisation of the work was based on each party of R.E. having it's own working party of requisite strength, and having one job only to do; thus, each trestle Bridge had 5 sappers and 10 carriers, each cork float Bridge had 6 sappers and 12 carriers, each wire netting mat had 3 sappers, and so on."

A Standard R.S.J lorry bridge built by a Field Company is shown on *Photograph* LVIII., and a lorry bridge of salved material on *Photograph* LIX.

Tank Bridge Over the River Selle. A crossing for tanks constructed entirely of old railway sleepers was made by one Company—details are shown on *Plate* XXXI.

The most important feature of the design is the strutting cribs against the banks.

If the bottom of the stream had been soft mud, sills would undoubtedly have been necessary.

In this crib a total bearing of about 40 square feet was available, one-third to half of which would probably have to take the total weight at a time.

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The actual settlement of the cribs after 4 tanks crossed was about 6″. The timbers of the crib were held in position by 1½″ diameter rods which were driven into the bottom of the river.

The crib was built up to the surface of the water, the sleepers being bored and fitted over the rods until the required height was obtained—12″ being allowed for sinkage under the weight of the tank. The crib was weighted with pieces of iron rail, to keep it in position.

This work was all done by night in close proximity to the enemy.

Details of this work are given on *Plate* XXXI.

(To be continued).

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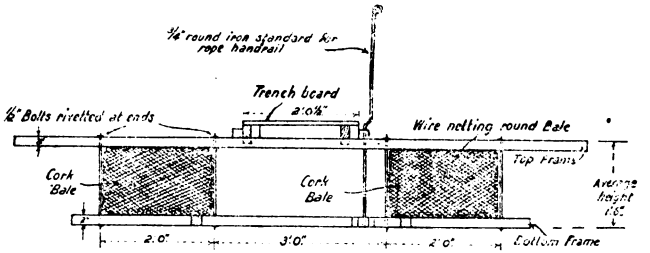
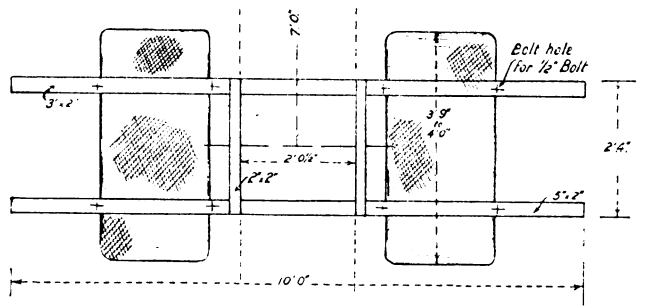
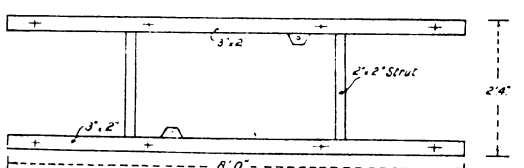


SECTION OF PIER



PLAN OF TOP FRAME OF PIER



PLAN OF BOTTOM FRAME OF PIER

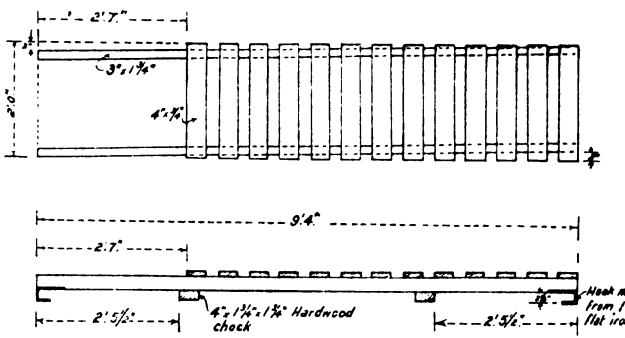
"Piers at 7 feet centres will carry fully equipped infantry in single file The Cork Bales are squared up and tightly bound in wire netting, 1½" to 2" mesh, before being compressed between the frames.

NOTES:-

(1) Average Weights:

Cork	2 x 75 lbs.	150 lbs
Top Frame.		39 "
Bottom Frame		24 "
Bolts.		3 "
Grating		47 "

(2) Buoyancy of Pier. 430 lbs.
(3) Four Bays with superstructure, pack on a pontoon wagon.
(4) The ½" Bolts require to be made specially.
(5) Wooden crates have been used to contain the Cork, but are of course, much heavier than the wire netting.
(6) Cork Slabs are superior to Cork Chippings.
(7) ¾" to 1" Steel cables are preferable to hemp cables as anchorages, as the latter are easily damaged by shell fire.



TRENCH BOARD

CORK BRIDGE PIERS.

PLATE XX.

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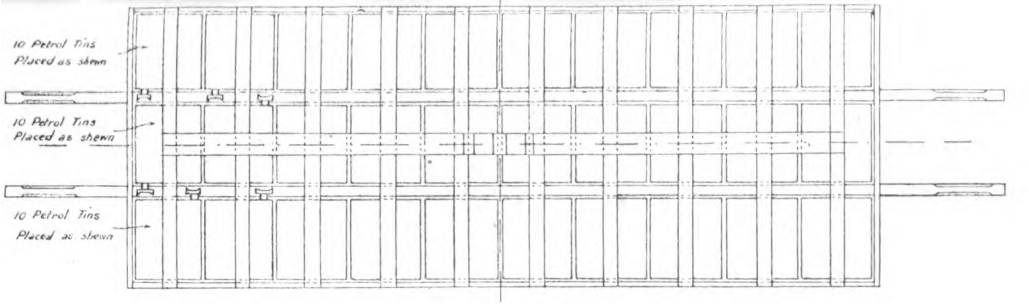
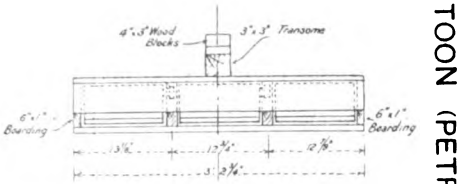
PONTOON (PETROL TIN FLOATS). PLATE XXI.

All connections simply nailed with wire nails in suitable lengths.

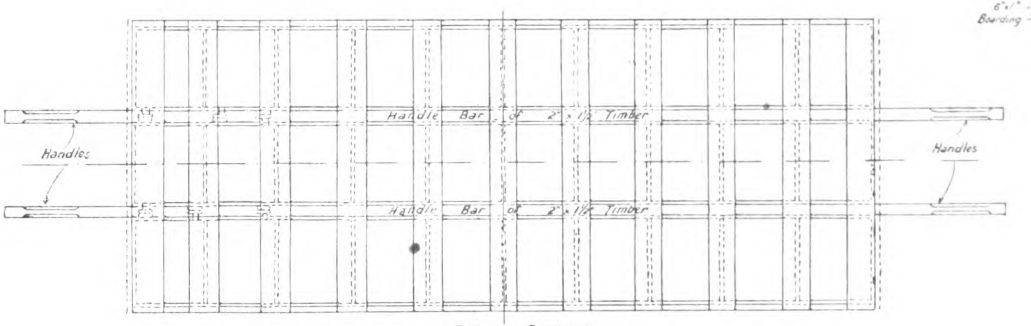
Handles of Petrol Tins "knocked off" before placed in frame.



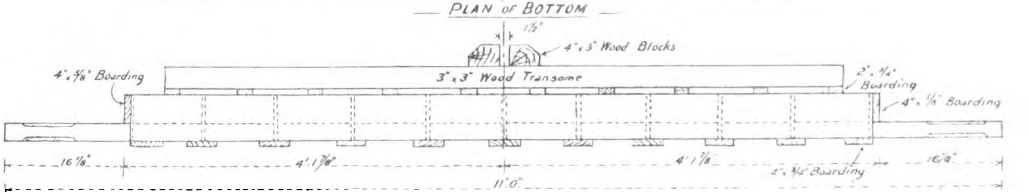
PLAN OF TOP



END ELEVATION



PLAN OF BOTTOM



SIDE ELEVATION

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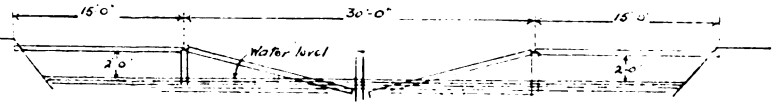
PILE BRIDGE FOR INFANTRY. PLATE XXII.

SHOWING ARRANGEMENT FOR DROPPING ROADWAY

When either pin is withdrawn, the transom falls, and the two ends of the roadway resting on this transom fall into the water; the other two ends of the roadway still rest on the fixed transoms as shown.

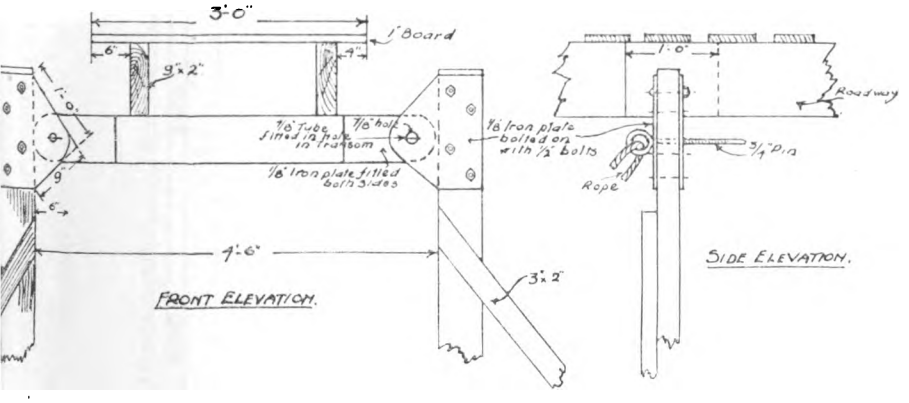


LONGITUDINAL ELEVATION. 8 in. Scale.

The gap made measures 30'; anyone putting his weight onto the collapsed roadway would be precipitated into the water.

If completely displaced from the other transoms which is quite possible, the roadway would float.

The collapsed roadway is not fastened in any way to the fixed transoms and would form a most insecure basis for any improvised bridge.



FRONT ELEVATION.

SIDE ELEVATION.

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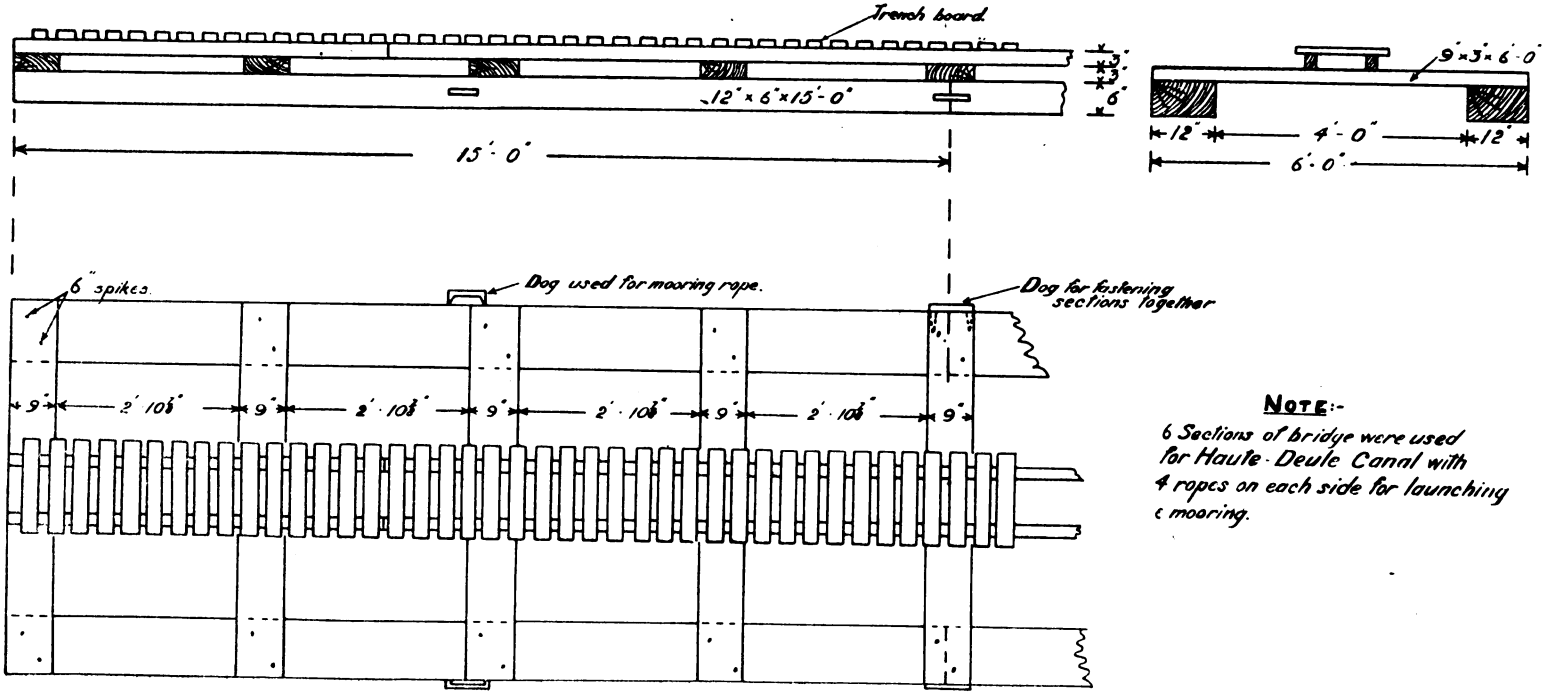
SKETCH SHOWING ONE SECTION OF FLOATING FOOT-BRIDGE.

PLATE XXIII.

TRANSPORT OF INFANTRY IN SINGLE FILE OVER HAUTE-DEULE CANAL. OCT., 1918.



NOTE:-

6 Sections of bridge were used for Haute-Deule Canal with 4 ropes on each side for launching & mooring.

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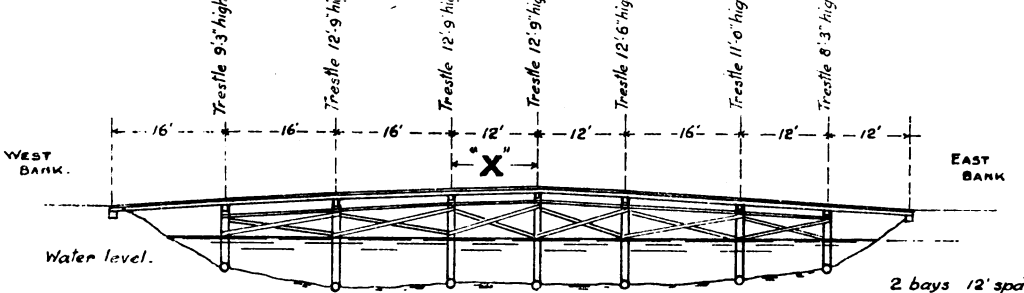
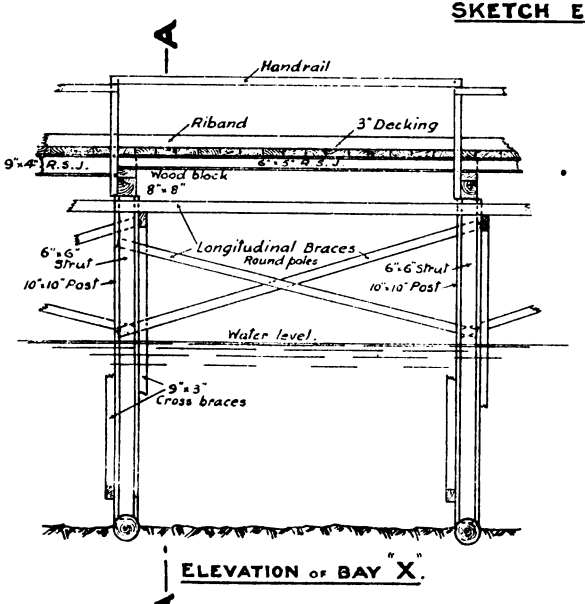


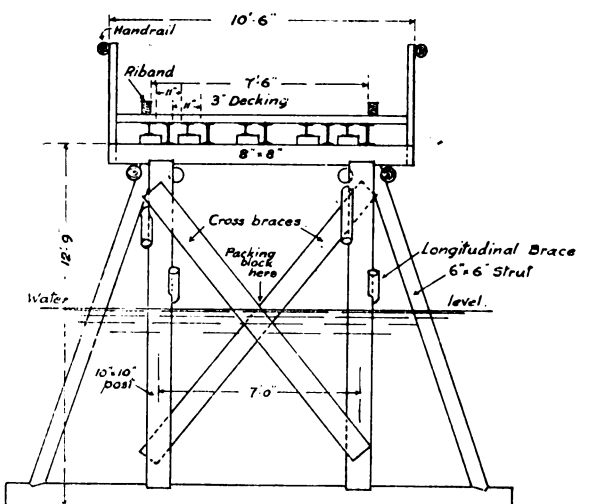
SKETCH ELEVATION OF BRIDGE.

NOTE:-

2 bays	12'	span	supported on	6"×5" R.S.J.s.
2 "	12'	"	"	8"×8" Timber Beams.
3 "	16'	"	"	9"×4" R.S.J.s.
1 "	16'	"	"	9"×4" " and Round Timber



ELEVATION OF BAY "X".



TRANSVERSE SECTION 'A-A'.

PLATE XXIV.

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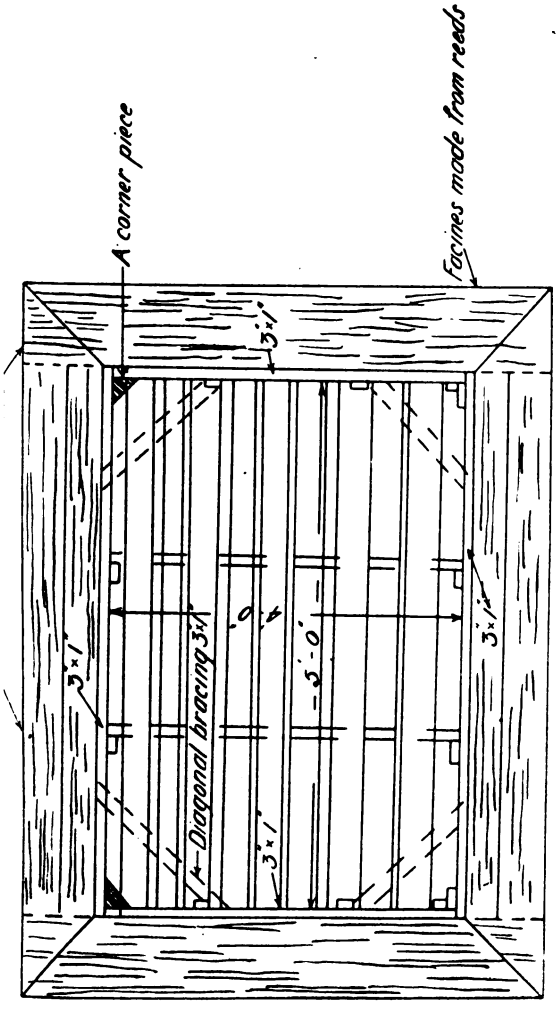
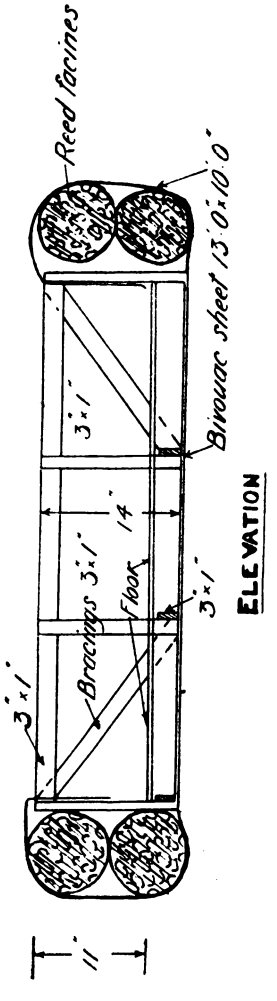
RAFT TO CARRY 4 MEN. PLATE XXV.

REQUIRES 4 MEN TO CARRY AND LAUNCH.



PLAN



ELEVATION

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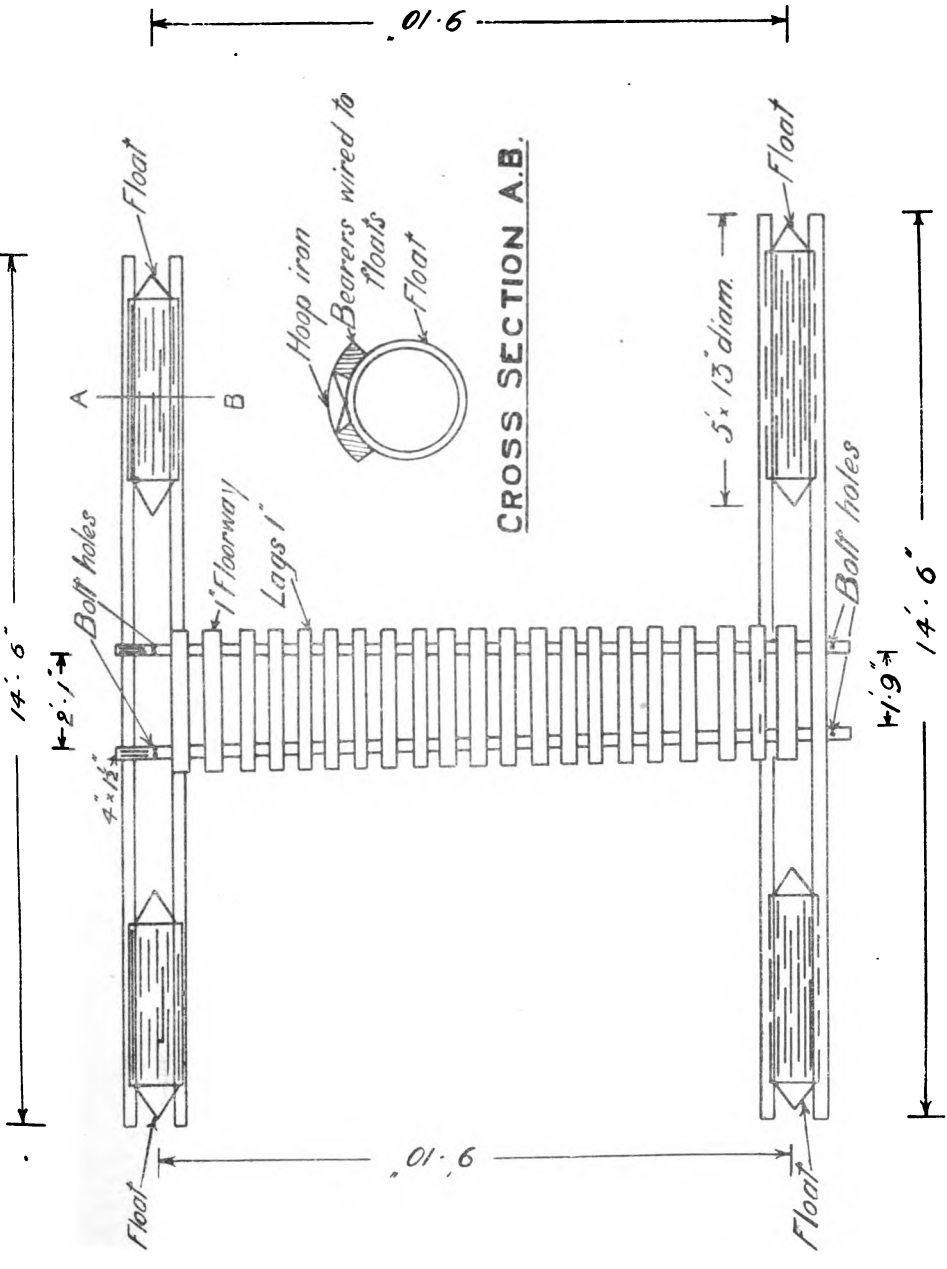
RAFT TO CARRY 3 MEN. PLATE XXVI.

REQUIRES 5 MEN TO CARRY OR LAUNCH.



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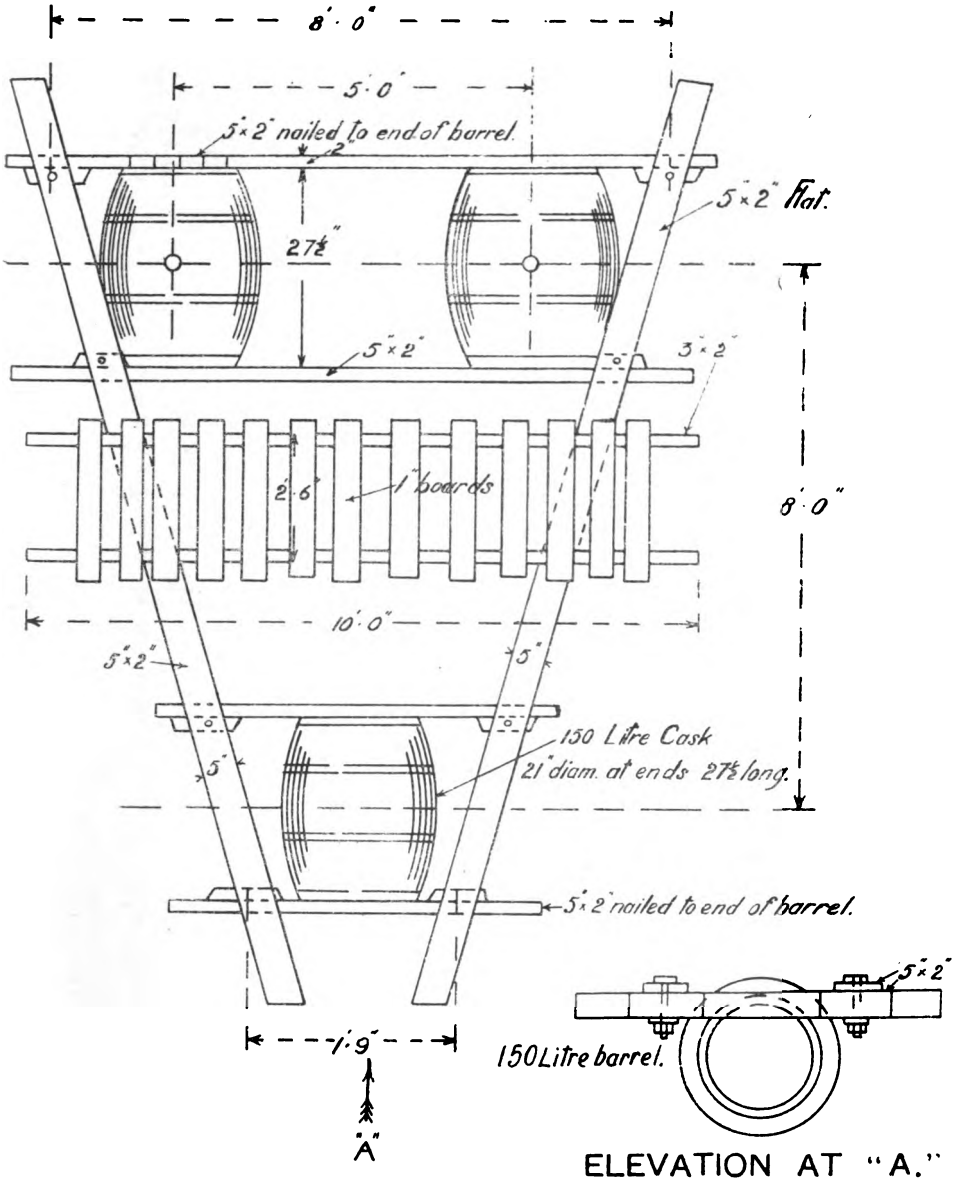
RAFT TO CARRY 3 MEN.

PLATE XXVII.

REQUIRES 7 MEN TO CARRY OR LAUNCH.



ELEVATION AT "A."

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CATAMARAN FOR RIVER CROSSING AT ESPAIN.

— MATERIALS —

2. 150 L Casks 33 gals.
2. 8ft Gunnels.
2. 10ft Runners.
2. 8'x6"x¾" Braces.
2. 8'x6"x¾" Stays.
1. 50 L. Cask.
Decking 6'x3".

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PLATE XXIX.

PLAN OF TIMBER TRESTLE BRIDGE AT PROUVY.

OCT. 28, 1918.

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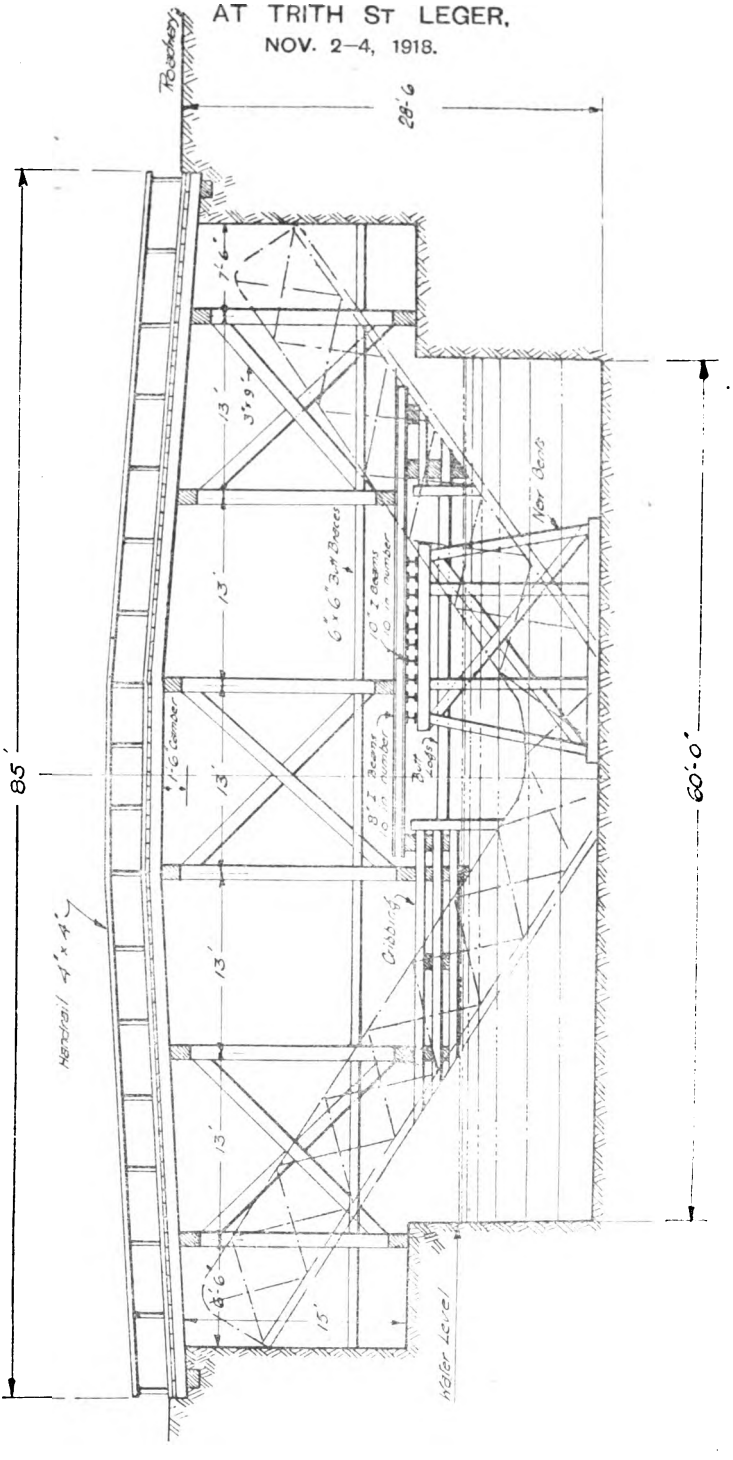
PLATE XXX.

PLAN OF TIMBER TRESTLE BRIDGE AT TRITH ST LEGER.

NOV. 2–4, 1918.



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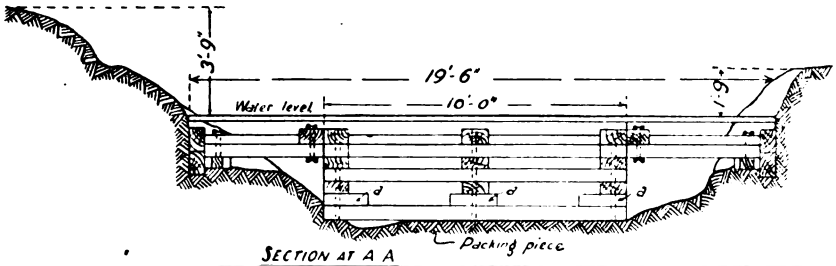
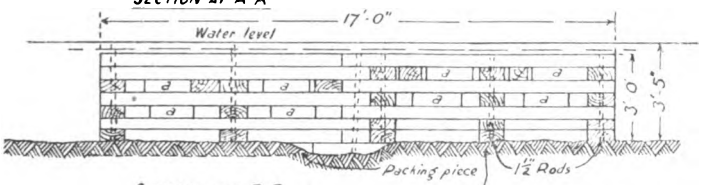
CRIB TANK CROSSING OVER RIVER SELLE.

BUILT OF RAILWAY SLEEPERS.



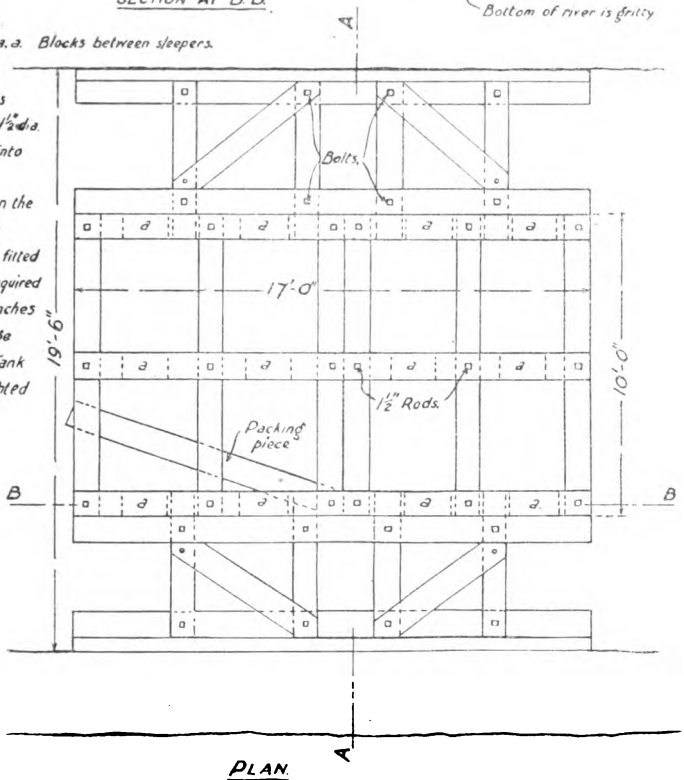
SECTION AT A A



SECTION AT B B

a. a. Blocks between sleepers.

The timbers of the Cribs were held in position by 1½" dia. rods which were driven into the bottom of the river. The Crib was built up on the surface of the water, the sleepers being bored and fitted over the rods until the required height was attained, 12 inches being allowed for sinkage under the weight of the Tank. The Crib was then weighted to keep it in position.



PLAN.

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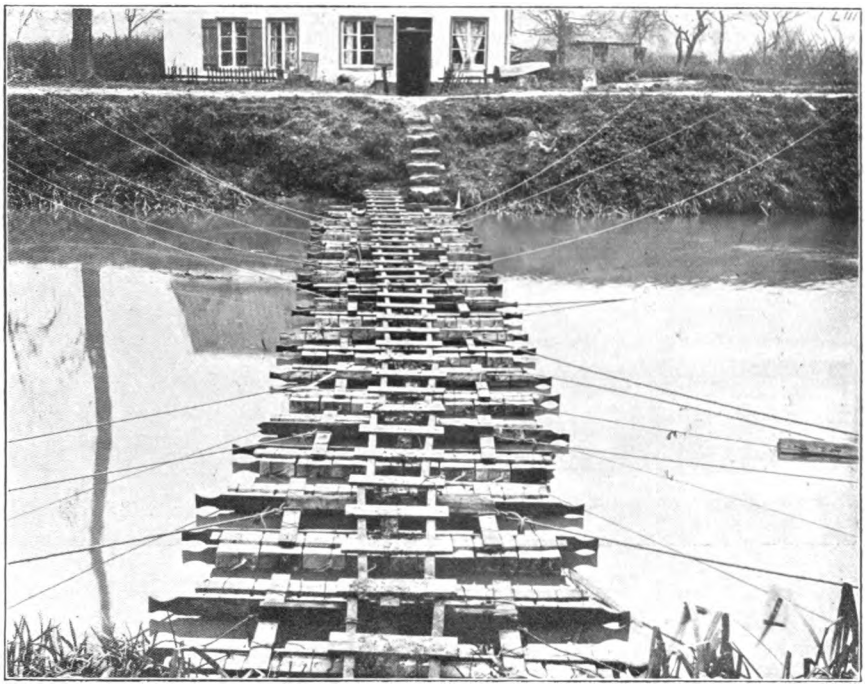
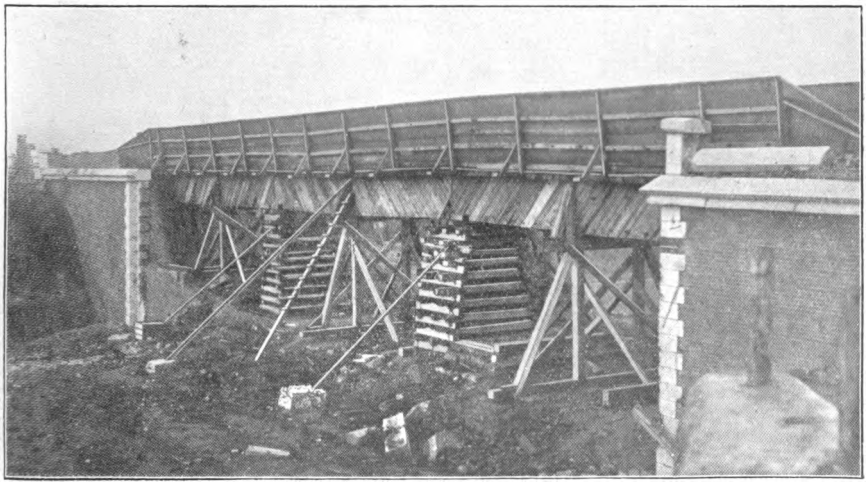


Photograph LIII.



Photograph LIV.

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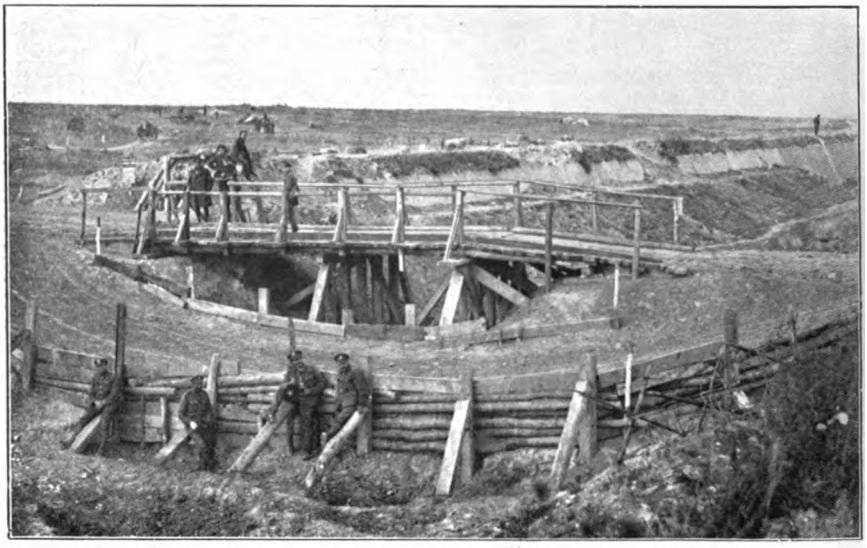

Photograph LV.

Photograph LVI.

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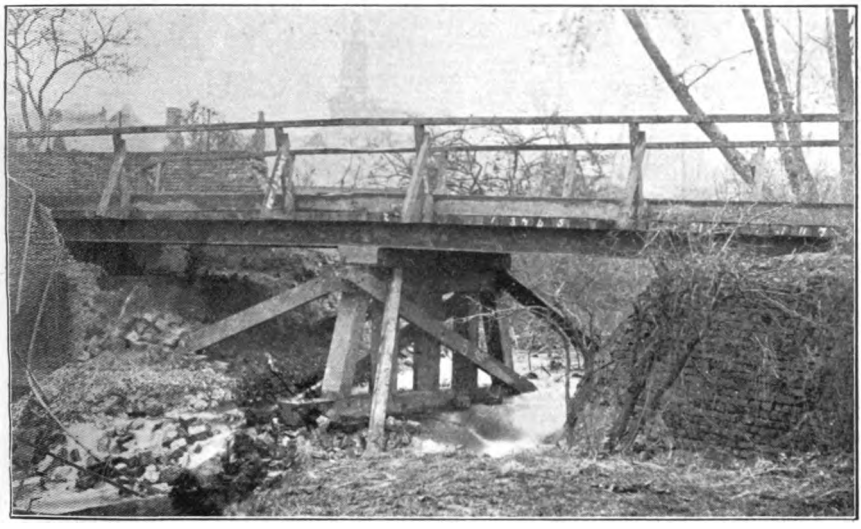

Photograph LVII.

Photograph LVIII.

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Photograph LIX.

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ORGANISATION OF ENGINEER INTELLIGENCE AND INFORMATION.

PART III., SECTION II.

Introduction.—Engineer Information with regard to the Theatre of War.—Collection and Circulation of Information on Field Engineering in our own and Allied Armies.—Collection and Compilations of material for Stationery Services Publications.—Examination and Circulation of Information with regard to Enemy Field Engineering Methods.

Appendices. A.—List of Plates of Field-work designs. B.—Engineer-in-Chief's Field-work notes. C.—Classified Index of Mining notes. D.—Engineer-in-Chief's D. and D.P. Publications. E.—Index to Engineer-in-Chief's Circulars (Stores Branch). F.—List of Engineer-in-Chief's "D" Publications. G.—List of German Field-Work Plates.

Introduction.—The work required fell under the following headings:—

(1). Collection of Engineer Information with regard to the Theatre of War.

(2). Collection and circulation of information with regard to new types of Field Defences, Mining, Camp Accessories, Engineer Stores, etc., evolved or suggested in the British Armies, and of notes of experience gained in operations and by experiment by our own Armies or those of our Allies.

(3). Collection and compilation of material for Stationery Services Publications, and keeping these publications up to date.

(4). Examination and circulation of information with regard to enemy Field Engineering methods.

Engineer Information with regard to the Theatre of War.—Very little Engineer information was available when hostilities commenced.

The principal data required are:—

(*a*) Nature and width of Roads, and their state in winter.
(*b*) Sources of road repair material.
(*c*) Dimensions of bridges and their safe loads.
(*d*) Nature of waterways and suitability for floating and pile bridges.
(*e*) Factories, workshops, brickyards and engineering material (particularly timber) available.
(*f*) Water Supply.
(*g*) Gas.
(*h*) Electric power installations and circuits.
(*j*) Telegraph and Telephone systems.

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(*k*) Geological conditions as regards surface, mining, minerals, and water supply.
(*l*) Inundations possible.
(*m*) Climatic and weather conditions.
(*n*) Fortresses.

There was no Engineer Staff either in the Intelligence or Fortification and Works Directorate for the special purpose.

A "Military Report on Belgium and the Grand Duchy of Luxemburg," of 78 pages, dated 1906, was issued, but it dealt only in generalities, as will be seen from the following extracts on Roads and Rivers:—

"The main roads in Belgium are either paved or macadamized."
River Meuse.—"Its current is swift in many places. while its depth is sometimes as much as 45 feet."

Five volumes of "Belgium Road, River and Billeting Reports" were available on disembarkation. They gave in the itineraries the nature and width of the Roads; the length and width of Bridges, but not the spans, safe loads, or size of the piers; water supply in general terms, "mostly wells and pumps," "well supply," "stand pipes in . . . . ."; and mentioned when there were telegraph lines alongside a road.

The information was in a particularly cumbrous form and could have been grasped much more quickly had it been given on maps.

No Engineer information about N.E. France was available.

The French were somewhat better provided with information, and eventually furnished us with a very limited number of copies of small hand-books called "Notice descriptive et statistique."

Each volume of this series dealt with a department of France or Province of Belgium or Germany. None, however, was of recent date, and beyond short descriptions of bridges (*e.g.*, "masonry abutments, roadway of timber on steel beams, one span 6.m., length 7.50 m., width 2.50 m."), details of Railways and Canals, number of wells, list of factories, contained little Engineer information.

These books, however, formed the foundation of our information.

(The "Report on Western Belgium and adjoining portions of France," issued by the War Office in May, 1916, was almost entirely derived from them. A "Report on Eastern Belgium" was never issued).

The data in these "Notices" were gradually supplemented by what could be obtained from officers of the French and Belgian Ponts et Chaussées, refugees, etc.

An appeal to the Staff of General Foch, who was at Cassel, when the British Army moved to Flanders in 1914, showed that the French General Staff had little Engineer information about their own Country.

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A visit to the Ministère de Guerre, Paris, revealed that there was nothing there except of historical value. (An enquiry there for information about the Lille Forts led to original documents signed by Vauban being exhibited).

The Headquarters of the First Army Corps (at Lille before the war), should have had the information, but such documents as it possessed were apparently left in Lille).

Officers who had served in the North of France when referred to, could give very little technical information.

Belgian Officers of Engineers, on the other hand, gave what proved accurate information of their country.

So little was recorded by the French Staff that the Canal-du-Nord was not shown on any Staff Map or referred to in any Military Publication.

Engineer information was first dealt with in the Engineer-in-Chief's office.

Pamphlets and Maps giving details of roads and bridges (Road and Bridge Books), and compilations on water supply, inundations and enemy fortresses were prepared.

In the compilation of Road and Bridge Books much help was got from the Belgian Ponts et Chaussées Officials at Ypres, and from whom a number of "Cahirs de Charge" (Bills of quantities for road and bridge maintenance contracts) were obtained and proved invaluable.

A great part of this particular information was collated by two Belgian Officials of the Ponts et Chaussées, specially attached to the Engineer-in-Chief's Office during most of the War.

Very great assistance was also got from a Belgian officer who had made a hobby for many years of touring the waterways in motor launches, and had picked up an extraordinary knowledge of the details of canals, waterways and bridges.

A good deal of information was also collected from picture post-cards obtained by advertisement and other means.

In March, 1916, it was decided that the work would be done by the Intelligence Department of the General Staff, to whom it was consequently transferred. This department had so much other work to do, that they had little time for Engineer Information, very little of which was contained in such Intelligence Publications as were issued from time to time with regard to the country in front.

The Engineer-in-Chief eventually continued as before to supply G.S. (O), Q.M.G., and Armies direct with information as to inundations, water supply, road metal, geological conditions on front as regards construction of dug-outs, electric power facilities, etc.

All information collected with regard to fortresses was passed to "I."

On a change of establishment in 1918, the Intelligence Section dealing with Engineer Information was, on the advice of the Engineer-

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in-Chief, reinforced by two R.E. Officers, and a definite arrangement made that the Engineer-in-Chief's specialists in geology, water supply, electricity, machinery, bridging, roads, inundations, etc., should compile what was required for " I " publications.

It was arranged that all communications with " I " should pass through one officer of the Engineer-in-Chief's Staff to ensure that information obtained by " I " was passed to the Officers concerned and that there was supervision of all intelligence work that left Engineer-in-Chief.

It was also arranged that when refugees and prisoners with technical information were examined an Engineer Officer should assist, for many opportunities for obtaining valuable information may be lost when non-technical Officers carry out interrogations of specialists.

A pamphlet compiled under the final system, " Notes on the Country East of Roubaix," was produced. The Note on Water Supply, and the Appendix on " Possible Inundations in the Schelde Valley," were compiled in the Engineer-in-Chief's Office.

Maps showing where road metal could be found, and nature of the bridges were issued separately.

It was not until the area was reached that information as to electric power installations was obtained.

The final system proved in every way satisfactory. " I " and the Engineer-in-Chief must work together in the matter, and it is convenient that each office should have one Officer told off who acts as the channel of communication with the other.

Even when a complete account of a Country is recorded in peace time, changes take place in war :—Bridges are destroyed, renewed or doubled, new roads, etc., are made. " I " alone has the machinery for getting news of this. Specialists must be employed to compile the technical information.

There would not be full time occupation for them in " I," and it seems in every way suitable to employ those working under the Engineer-in-Chief.

Part of the technical information, *e.g.*, *re* roads, water, etc., is required by Staffs of Formations and not by the R.E. alone, and is best issued by " I " to prevent overlapping.

Other information, *e.g.*, with regard to road metal, electrical circuits, loads, is only required by the R.E., but it is best to issue it through " I," or, at any rate, to consult " I " before issue.

The Intelligence Department was not responsible for Engineer Information with regard to country, except what was behind the enemy's line ; for that behind our own front the E.-in-C. was expected to arrange, but had no special staff for the purpose. A commencement was made at collecting this, but was interrupted by the retirement in March, 1918.

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Some definite machinery is required for it, as the dimensions of the Bridges and nature and widths of Roads, sufficiency or otherwise of the number of Roads and Bridges, areas suitable for dug-outs, areas it was possible to inundate, were not recorded when required in the Spring of 1918, and reconnaisances had to be hurriedly carried out.

Collection and Circulation of Information on Field Engineering in our own and Allied Armies.—Such information on Field Engineering as it was considered desirable to circulate was originally issued in "Notes from the Front," collated by the General Staff, and "Notes on Field Defences," 1914.

It was not until early in 1916 that a regular series of R.E. Publications took form. These were :—

(*a*) E.-in-C. Plates of Field Work Designs (Appendix A.)
(*b*) E.-in-C. Field Work Notes (Appendix B.)
(*c*) Mining Notes (Appendix C.)
(*d*) D.P. series of Plates of huts or other Camp accessories (Appendix D.)
(*e*) E.-in-C. Circulars, Stores Branch (Appendix E.)
(*f*) Standard Bridge Drawings.
(*g*) Drawings and descriptions of articles made in R.E. Workshops.

Lists of these Plates and Notes are attached, with the exception of (*f*) and (*g*), details of which will be found in the Sections dealing with Bridging, and Workshops respectively.

Short notes of ephemeral interest, and small matters which it was desired to bring to the attention of C.E.'s, but which were not of sufficient importance to circulate generally, were also issued as Series "D" (Appendix F.) The use of this Series was not consistent, but it is certainly of advantage to deal with such matters in a continuous series, kept together for reference, rather than to issue them under unconsecutive numbers of a Central Registry.

The material for the above plates and notes was obtained by contributions from formations and units, visits of Liaison Officers, calling for reports on special subjects (*e.g.*, the effect of shell-fire on concrete structures), experiments conducted at G.H.Q., the R.E. Training School, Rouen, Mine Schools, etc.

Selection, compilation, editing and publication were dealt with by the three sections of the Engineer-in-Chief's Office—Defences, Mining, and Stores, until 1918, when it was arranged that all publications should pass through the hands of one Officer before issue.

The method of issue was as a rule that the proofs of plates and notes were sent to the Chief Engineer of each Army, who then said how many copies he required, and thus controlled the issue in his Army.

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500 copies of each publication were eventually, by request, sent to the War Office for issue to home and to other Expeditionary Forces

The Engineer-in-Chief ordered the number of copies required and issue was made direct from his Office.

It would seem advantageous that in future an Engineer-in-Chief's Office should have a section for publication and issue of information.

Summaries were issued of the French Secret Publication, "Bulletin de Renseignements du Génie," containing much valuable information, of which eight Volumes were issued, and also of the Official French Publications :—

"Instruction sur les travaux de Campagne," December, 1915.
"Instruction sur l'organisation du Terrain," Parts I. and II., 1917.
"Instruction sur l'organisation et la Construction des batteries." 1917.
"Ecole des Mines." 1914 (Elementary).
"Ecole des Mines" (Livre de l'Officier), 1914 (Advanced), with Supplement, 1917.

The Russian and Italian Official Publications were examined, but as they contained no new or novel matter, nothing with regard to them was issued.

The American publications, being derived mainly from British ones, it was unnecessary to bring to general notice.

The form they were issued in—loose leaved, 6 in. × $3\frac{1}{2}$ in., with round edges—was very convenient.

Stationery Services Publications.—The first general pamphlet on Field Engineering was "Notes for Infantry Officers on Trench Warfare," March, 1916.

This was prepared without reference to the Engineer-in-Chief, although a few diagrams issued by him were included in it.

Subsequently all Publications on Engineer matters were prepared in the Engineer-in-Chief's Office.

A revised set of diagrams for the above pamphlet was issued in December, 1916. This was superseded by S.S. 196, "Diagrams of Field Defences," March, 1918

Other S.S. publications of engineer interest were :—

S.S. 145 "Notes on R.E. Preparations for, and the employment of the R.E. in Offensive Operations," revised in January, 1918, as "Notes on Engineer Work during Operations."

Founded first on the experience of 1915 at Neuve Chapelle and Loos, it was entirely re-written after the Battle of the Somme, and largely added to after Vimy and Messines, in 1917.

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S.S. 208. "Field-works for Royal Artillery."
S.S. 220. "Field-works for Pioneer Battalions."
S.S. 202. "Organisation of Shell Hole Defences."
S.S. 177. "Instructions on Wiring" (Rapid Wiring).
S.S. 108. "Notes for C.R.E.'s on Organisation of R.E. Work when holding a line." March, 1916.
S.S. 104. Précis of Divisional R.E. Instructions to a Division about to take over a line." March, 1916.
S.S. 112. "Consolidation of Trenches, localities and craters after assault and capture." May, 1916.
S.S. 219. "Notes on Road Building."
S.S. 116 "Notes on cover against Shell-fire" (Revised, December, 1916).
S.S. 182. "Instructions on Bombing" Part I. (British and German Bombs).
S.S. 206. "The Principles and Practice of Camouflage."
S.S. 180. "Notes on Screens."
S.S. 115. "Notes on Mining" (translated from the French).

S.S. 135 "The Division in Attack" (Revised Edition, November, 1918), and S.S. 210, "The Division in Defence," May, 1918, contain valuable instructions as to the employment of the R.E.

After each pamphlet was issued arrangements were made for an Officer to take charge of it and collect materials for a revised Edition as they came to notice.

The experiment of bringing in special Officers into the Engineer-in-Chief's office to compile pamphlets was not altogether a success.

It was found preferable and more expeditious for Officers trained in compiling to put the material available together and then to submit the MS. for examination to one or more C.E.'s or C.R.E.'s as seemed desirable, for criticism and advice.

Examination and Circulation of Information with regard to Enemy Field Engineering Methods.—This was done in conjunction with G.S., Intelligence.

All information obtained by "I" was sent over to Engineer-in-Chief for examination and recommendation as to whether it should be issued to the Armies or not; information obtained by Engineer-in-Chief from Engineer sources was similarly treated.

Matters of immediate importance, *e.g.*, enemy traps, grenades, were prepared for reproduction and handed to "I" for issue in the "Ia" series; others were prepared for publication in the series "German Field Work Plates" (Appendix G.)

Engineer-in-Chief also undertook the revision of "I" translations on Field Engineering. The most important was:—"Stellungsbau" (the Construction of Field Positions), with the four Editions of the

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"Introduction," laying down the general principles of the use of field defences.

As time went on and the mass of information about the Country ahead increased, and the Staff of the Engineer-in-Chief's Office changed (in November, 1918, there was only one Officer and one Clerk who were in the Engineer-in-Chief s Office in November, 1914), it was found necessary to appoint an Officer to index and take charge of all information, records, books and maps, so that if anything was wanted it could be readily found. Unless this is done, information is apt to get lost sight of, not only at G.H.Q., but by fighting formations, which it was necessary to remind. The Officer combined this work with charge of the draughtsmen's office.

Thus three Officers were eventually required to deal with information; and one to do liaison with "I"; one to deal with the issue of Publications, and one to take charge of records.

Reproduction of Engineer Publications was undertaken and done most expeditiously by the Army Printing and Stationery Services in the Field; very urgent work was done by the Printing Section of the Field Survey Depôt Battalion, G.H.Q.

APPENDIX A.

List of Plates of Fieldwork Designs.

Issued under E.-in-C., Nos. $\frac{\text{FF}}{1 \text{ to } 146}$

No. 1. Elliptical Concrete Dug-out (for water-logged clay). (Cavalry Corps.)
,, 2. Brick Tower Artillery O.P.
† ,, 3. Light Canvas Collapsible Gabion (*Fig.* 17.)
‡ ,, 4. Trench Frames. Do. do.
† ,, 5. Collapsible Knife Rest with angle iron ends. (First Army.) (*Fig.* 34.)
† ,, 6. Collapsible Wire Netting Gabion. (French.) (*Fig.* 17.)
,, 7. German Front Trench System with keep and bomb stops.
,, 8. Keep and Bomb Stop. (Third Army Infantry School.)
,, 9. Bomb Stops. Do. do.
,, 10. Sentry Post. (1st Division.)
,, 11. Ryes O.P. Plate with specimens of its use.
,, 12. Artillery Shelters. (I. Corps.) 18-pdr.
,, 13. Do. 60-pdr. (*See* No. 27.)
,, 14. Concrete M.G. Emplacement. (I. Corps.)
‡ ,, 15. Deep Dug-outs. (1st Division.)
† ,, 16. Shelter made with ½-in. "Elephant" sheets. (*Fig.* 68.)
† ,, 17. Small C.I. Shelter. (*Fig.* 67.)
‡ ,, 18. Entrance to Deep Dug-out.

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No. 19. Double Roof Timber Shelter for 18-pdr. (VII. Corps.)
‡ ,, 20. Deep Dug-out. (IV. Corps.)
‡ ,, 21. Do. Entrance. (IV. Corps.)
,, 22. 2-in. T.M. Emplacement. (First Army.)
,, 23. Shelter for 4·5-in. Howitzer. (153rd Field Co. R.E.)
,, 24. 9·45-in. T.M. Emplacement. (II. Corps.)
† ,, 25. M.G. Emplacements and Dug-outs. (IV. Corps.) (*Fig.* 51.)
,, 26. M.G. Emplacement in Breastwork. (2nd Field Co., R.E.)
,, 27. Shelter for 60-pdr. (I. Corps.) (*See* No. 13.)
† ,, 28. Mock Sandbag O.P. (*Fig.* 69.)
,, 29. Baby "Elephant" Dug-out. (55th Division.)
,, 30. Dressing Station, 15th Division.
† ,, 31. Concertina Barbed Wire. (First Army.) (*Fig.* 35.)
,, 32. Do. do. (Second Army.)
,, 33. Concrete O.P. Tower. (XIV. Corps.)
,, 34. Concealed M.G. Emplacement with counter weight roof. (Captain Foot, R.E.)
,, 35. Giant Disappearing Periscope. (2/2nd West Lancs. Field Co., R.E.)
,, 36. Four Hours Covered M.G. Emplacement. (121st Field Co., R.E.)
,, 37. Blocking Gate. (Second Army.)
† ,, 38. Parapet Hurdle made of cement cask. (25th Army Troops Co.) (*Fig.* 14.)
† ,, 39. Typical Deep Dug-out. (Third Army.) (*Fig.* 61.)
† ,, 40. Lookout Box for O.P. with sliding steel plates. (*Fig.* 69.)
† ,, 41. Improvised Water Level. (Third Army.) (*Fig.* 41.)
† ,, 42. Deep Dug-out near front line with emergency exit. (*Fig.* 64.)
,, 43. 9·45-in. T.M. Emplacement. (Fourth Army). (A.A's. pattern.)
† ,, 44. Shielded Sniper's Post. (First Army.) (*Fig.* 71.)
,, 45. Concertina Barbed Wire. (3rd Aust. Division.)
† ,, 46. Sniper's Loophole and Post. (2nd Division.) (*Fig.* 72.)
,, 47. Field Dressing Station. (61st Division.)
,, 48. Do. do. do.
† ,, 49. Splinter and Bullet Proof Sentry Post. (154th Field Co.) (*Fig.* 70.)
,, 50. Harwood EXPM Revetting Hurdle. (2nd Division)
,, 51. Aid Post Sorting Station. (32nd Division.)
,, 52. Field Magazine. (32nd Division.)
,, 53. S.A.A. Magazine. (32nd Division.)
,, 54. Latrine. (1st Australian Division.)
‡ ,, 55. Trench Revetting Truss. (32nd Division.)
† ,, 56. Communication Trench Defences, Dog Legs, Loop-holed Traverses. (32nd Division.) (*Fig.* 37.)
† ,, 57. Armoured Sentry Box. (32nd Division.) (*Fig.* 73.)
,, 58. Design for Dug-out under parapet with covered Sentry Posts. (VII. Corps.)

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No.	59.	Shell-proof Dug-out. (I. Anzac Corps.)	
,,	60.	Shell-proof Dug-out (I. Anzac Corps), in low-lying water-logged areas.	
,,	61.	Candle Lantern made from Biscuit tin. (25th A.T. Co.)	
,,	62.	Dimensions of Gun Emplacements. (Artillery Adviser, G.H.Q.)	
,,	63.	Cruciform Post. (III. Corps.) (*See* Fieldwork Notes No. 13.)	
,,	64.	Type of Dug-out. (1st Division.)	
,,	65.	Double Spiral Staircase for Entrance to Deep Dug-outs. (New Zealand Division.)	11 - 16.
,,	66.	Portable Revetment Frame. (105th Infantry Bde.)	11 - 16.
‡ ,,	67.	Cruciform Strongpoint for a Platoon. (56th Divnl. Engineers.) (*See* Fieldwork Notes No. 13.)	10 - 16.
,,	68.	Bomb Post Block for Communication Trench behind Front Line. (46th Division.)	
,,	69.	Deep Dug-outs, examples of recent practice.	12 - 16.
,,	70.	Mined Passages to Deep Dug-outs.	12 - 16.
,,	71.	Dimensions of Gun Emplacements. (18-pdr. and 4·5 Howitzer.)	1 - 17.
,,	72.	Light Railway Trolley. (32nd Division.)	12 - 16.
,,	73.	Bomber's Pit. (8th Division).	12 - 16.
,,	74.	Mud Toboggan. (32nd Division.)	12 - 16.
,,	75.	Speaking Tube Fittings. (First Army Workshops.)	1 - 17.
,,	76.	Concealed Machine Gun Emplacement—Imitation Shell Hole. (170th Co., R.E.)	1 - 17.
,,	77.	Sniper's Post. (First Army Workshops.) Double Framework.	1 - 17.
,,	78.	Defence of Infantry Subways. (Limited Issue.)	1 - 17.
,,	79.	Field Periscope.	1 - 17.
,,	80.	Portable Bunk. (Third Army.)	1 - 17.
‡ ,,	81.	Standard Trench Frames. (*See* Fieldwork Notes No. 23.)	1 - 17.
,,	82.	Notes on Types of Dug-outs in use in Second Army.	2 - 17.
,,	83.	Device for Lacing together X.P.M. sheets in Revetments. (1/3rd Kent Field Co., R.E.)	2 - 17.
,,	84.	Underground Cookhouse. (35th Division.)	1 - 17.
,,	85.	Gate and Frame for flank defence of front line posts. (126th Field Co., R.E.)	2 - 17.
,,	86.	Baby " Elephant " Shelter, with bursting course on frames. (II. A.N.Z.A.C.)	2 - 17.
,,	87.	Whittall's Stokes Gun Emplacement. (16th Division.)	4 - 17.
,,	88.	Short Revetting Frames. (Second Army pattern.)	5 - 17.
,,	89.	Cover for Heavy or Medium Trench Mortar Emplacement. (Third Army School of Mortars.)	6 - 17.
,,	90.	Subways :—Typical Arrangement of Galleries and Accessory Dug-outs.	6 - 17.
,,	91.	Carey's Water Carrier for Pack Mules. (4th Canadian Division.)	3 - 17.
,,	92.	Observation Post. (29th Division.)	8 - 17.
,,	93.	Improvised Pack Saddlery. (430th Field Co., R.E.)	8 - 17.
,,	94.	Shell Slit for Protection of two or three men guarding entrance of Dug-out. (III. Corps.)	7 - 17.

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No. 95.	Heavy Trench Mortar Emplacement. (3rd Aust. Tunnelling Co.)	8 - 17.
,, 96.	Dug-out Entrance. (251st Co., R.E.)	8 - 17.
,, 97.	Tank Causeway. (184th Tunnelling Co., R.E.)	8 - 17.
,, 98.	Jump Crossing for Tanks. (184th Tunnelling Co., R.E.)	8 - 17.
,, 99.	Pack Saddle Attachment for carrying barbed wire or long screw pickets. (61st Division.)	9 - 17.
,, 100.	Ambulance Bogey. (XIV. Corps Troops.)	8 - 17.
,, 101.	Pontoon. (Petrol Tin Floats). (XIV. Corps Troops.)	8 - 17.
,, 102.	Decks. (Petrol Tin Floats). (XIV. Corps Troops.)	8 - 17.
,, 103.	Plan and Details shewing connection of Decks to Floats and Shore. (XIV. Corps Troops.)	8 - 17.
,, 104.	Water Barrel Bogey. (XIV. Corps Troops.)	8 - 17.
,, 105.	Well Head Windlass and Frame. (XIV. Corps Troops.)	8 - 17.
,, 106.	Hut Shelter. (III. Corps.)	6 - 17.
,, 107.	Hut Shelter, High Sides. (III. Corps.)	11 - 16.
,, 108.	Incinerator of Angle Iron and small steel shelter. (III. Corps.)	6 - 17.
,, 109.	Reinforced Concrete Horse Trough. (148th A.T. Co.)	7 - 17.
,, 110.	Entrance Frame.	10 - 17.
,, 111.	Screen for Water Tank. (148th A.T. Co.)	7 - 17.
,, 112.	'Y' Frame for repair of trenches.	17.
,, 113.	M.G. Emplacement (Champagne type). (With inclined shaft to dug-out).	9 - 17.
,, 114.	M.G. Emplacement (Champagne type). (With vertical shaft to dug-out).	9 - 17.
,, 115.	Medium Trench Mortar Emplacement. (Embrasure in the communication trench).	9 - 17.
,, 116.	Medium Trench Mortar Emplacement. (Embrasure disguised as a shell hole).	9 - 17.
,, 117.	Ferret Bomb.	10 - 17.
,, 118.	Machine Gun Emplacement. (Champagne Type). (Cancels FF/113 and FF/114).	11 - 17.
,, 119.	Expanded Metal Revetting Hurdle.	11 - 17.
,, 120.	Gas Blanket arrangement under various conditions.	12 - 17.
,, 121.	French Wire—New method of preparing coils for carrying.	12 - 17.
,, 122.	Cable throwing from Livens Projectors.	11 - 17.
,, 123.	Sandbag Filler.	
,, 124.	H.T.M. Emplacement and Ammunition Chamber.	1 - 18.
,, 125.	Method of Breaking-away Chambers from a Dug-out Gallery.	1 - 18.
,, 126.	Camouflage Cover for M.G. Emplacement.	
,, 127.	Gas Protector Frames.	1 - 18.
,, 128.	Instructions for Repair of Old and Impassable Trenches.	2 - 18.
,, 129.	Field Gun Emplacement to give All Round Fire.	2 - 18.
,, 130.	Light Bridge for Raiding.	2 - 18.
,, 131.	8-inch Proof Shaft Dug-out.	- 18.
,, 132.	Destruction of a Concrete O.P. by Guncotton.	3 - 18.
,, 133.	(I). Tank Ditch. (II). Dug-out Entrance.	5 - 18.

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No. 134.	Machine Gun Platform Table.	18.
,, 135.	Type Plan of M.G. Position for 4 Guns.	5 - 18.
,, 136.	Spider Wire Entanglement	18.
,, 137.	Machine Gun Emplacement (Champagne Type) (Cancels FF/118).	18.
,, 138.	Machine Gun Emplacement with " Longfield " Trch. Mtg.	6 - 18.
,, 139.	Cork Bridge Piers.	6 - 18.
,, 140.	Instructions for the erection of the Moir Pill Box.	8 - 18.
,, 141.	O.P. in Building, using Rye's Plates.	8 - 18.
,, 142.	Provisional instructions for the erection of Hobbs' Pill Box)	9 - 18.
,, 143.	Reinforced Concrete Shelter.	18.
,, 144.	Reinforced Concrete " Pancake " Shelter.	18.
,, 145.	Protection of Shelters against Direct Hits from Bombs.	11 - 18.
,, 146.	Floating Bridge for Infantry in File.	18.

NOTES.—†Reproduced in " Revised Diagrams, December, 1916," of " Notes of Trench Warfare for Infantry Officers ; " the number of the Figure given in brackets after the title is the reference to this publication.
‡Superseded by later patterns.

APPENDIX B.

ENGINEER-IN-CHIEF'S FIELDWORK NOTES.

No.	SUBJECT.
1.	Defence of Communication Trench.
2.	Saps to Craters, with Bombers' Pits.
3.	Back Entrances to Deep Dug-outs and Concealment of T.M. Emplacements.
4.	Reclamation of Trenches ; Concealment of Work ; German Cover against Shell Fire.
5.	Protection of Entrances of Deep Dug-outs from Flooding.
6.	Report on Experiments and Experience with Torpedoes and Pipe Forcing Jacks for Clearing Gaps through Barbed Wire Entanglements.
7.	German Concrete Construction, Rusty Wire, Shelters to L. Trenches.
8.	Concealment, Notes on recent Operations.
9.	Underground Galleries under No Man's Land. Notes on Recent Operations. Enemy Defences.
10.	Extracts from Reports on the Somme Operations.
11.	Use of Pipe Pusher and Wombat Boring Machine, Hits by German Heavy Minenwerfer.
12.	Timber and Canvas Plate Girder Bridge. (No copies available).
13.	Strong points.
14.	Extracts from Reports on the Somme Operations.
15.	Cut and Cover Trenches for Light Railways.
16.	Extracts from Reports on the Somme Operations.
17.	Mined Dug-out Construction.
18.	Arrangements for Indirect Machine Gun Fire.
19.	Pontoon Bridge for Lorry Traffic.

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No.
20. German Traps.
21. Bangalore Torpedoes.
22. Forward Tramlines in Trench Warfare.
23. Deep Revetting Frames.
24. Timber Plate Girder Bridge.
25. Effect of Mobile Charges on Dug-outs.
26. Infantry Sub-ways.
27. Enemy Mines and Demolitions.
28. Temporary Road Bridge Constructed by 62nd Divisional Engineers over a Flooded Area.
29. Cover from Shell Fire :—Précis of Results of Experimental Firing with 5·9-in. Shells carried out by Belgian Army, February and March, 1917.
30. Pontoon Bridges for Motor Transport.
31. German Concrete Structures on Messines Ridge and the Effect of Shell Fire on them.
32. Concealment of Isolated Machine Gun Positions and Emplacements.
33. Extracts from Reports by Chief Engineers and C.R.E.'s who took part in the Operations of the Second Army at Messines Ridge.
34. Notes on Construction of Trench Tramways during Messines Operations.
35. Extracts from Reports of Chief Engineers and C.R.E.'s on Recent Operations (excluding those of Second Army) and from Suggestions for a New Edition of S.S.145, " Notes on R.E. Preparations for, and the Employment of the R.E. in Offensive Operations."
36. Improvised Torpedo for Wire Cutting left behind by the Germans on the Occasion of a Recent Raid. (C.R.E., 35th Division, 22.7.17).
37. Notes on Forward Road Construction.
38. Use of Thermit to Render Guns Temporarily Unserviceable.
39. Experimental Tests of Types of Revetment.
40. Destruction of German Explosives.
41. Type of Rapid Shelter.
42. Example of Rapid Construction of a Ferro-concrete Shelter, etc.
43. German Concrete Structures in the area North of Ypres Captured in August, 1917, and the Effect of Shell Fire on them.
44. Temporary Patching of Berthon Boats, etc., etc.
45. Instructions for Construction of Trenches and Repairs of Trenches.
46. Effect of Bombing on Dug-outs.
47. Report on Test of Reinforced Concrete Machine-gun Emplacement at Kemmel.
48. Use of Ferro-concrete in Dug-out Construction.
49. Demolition of a Tank.
50. Notes on Road Construction.
51. Demolition of Derelict Tanks.
52. Road Craters.
53. Notes on Demolitions.
54. Abbreviated Translation of French Pamphlet on Engineer Stores.
55. Notes on Demolitions. (Addendum to E-in-C. Fldwk. Note No. 53).
56. Concrete Block Shelters.
57. Well Demolitions.

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No.
58. Collapsible Boats.
59. German Traps and Mines.
60. Firing Demolition Charges with Cordeau Detonant.
61. Firing Demolition Charges Electrically with Torch Batteries (A.O.D. Supply).
62. Dummy Trenches.
63. Experiment to test the best form of Junction Box for Instantaneous and Safety Fuze.
64. Deliberate Demolitions.

APPENDIX C.

CLASSIFIED INDEX OF MINING NOTES.

(Nos. 1 to 100.)

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D/115.	"Wilson" Trench Monorail.
D/123.	Improvised Stoves.
D/124.	Field Cooker.
D/125.	Oven.
D/131.	Improvised Incinerator.
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D/135.	Portable Hut.
D/145.	Shelf and Brackets, Nissen Bow Huts.
D/146.	Nissen Bow Huts, Packing of Parts.
D/148.	Corrugated Steel Shelter, English Pattern.
D/154.	Heating Apparatus: Drying Room.
D/155.	Reservoir to hold 50,000 galls.
D/162.	Canadian Pattern Stove, Small size.
D/166.	Semi-Portable Stove.
D/174.	Bayonet Fighting Gallows.
D/179.	Artillery Bridge, Second Army, "A" type.
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D/186. Shower Baths, Arrangement and Details of.
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D/211. Do. Small.
D/226. Sectional Canvas Troughing.
D/230. Nissen down draught Incinerator.
D/233. Latrines.
D/240. Belt Pumps.
D/251. Axle Wheels and Axle Box.
D/256. Roofing for Stables and Shelters.
DP/272. Tarrant "Dechets" Hut.
DP/273. Sommerville Portable Hut.
DP/277. Details of Flap Bridge.
DP/278. R.E. Stove, Type A.
DP/279. Do. Type B.
DP/280. Do. No. 2.
DP/281. Do. No. 3.
DP/293. Constructional Drawing, Sergeants' Mess.
DP/294. Do. Officers' Mess.
DP/295. Type of Camp Buildings.
DP/296. Company Cooking Shelter.
DP/297. Dining Room, 100 ft. × 28 ft.
DP/298. Bath House for 1,000 men.
DP/299. Buildings for C.C.S.
DP/300. Shower Bath and Disinfector Shed, C.C.S.
DP/301. Drying Room for 1,000 men.
DP/302. Drying Room.
DP/303. Drying Rooms.
DP/304. Roofing and Horse Shelters for Field use.
DP/305. Tarrant Huts for C.C.S., 200 beds.
DP/306. Accommodation in camp.
DP/321. Nissen Bow Hut.
DP/323. Roofing for Ammunition Dumps.
DP/330. Nissen Hospital Hut.
DP/339. Kitchen and Ovens, No. 9 C.C.S.
DP/346. 4 in. Plug Valve for Outlets in Reservoir.
DP/347. Roofing for Ammunition Dumps, Mark II.
DP/365. 2 Berthon Boats to form Raft.
DP/396. Tarrant Portable Hut, Mk. II.
DP/414. Light Shedding for Workshops and Stores.
DP/421. Water Cart Filling Points.
DP/480. Water Bottle Filler.
DP/485. Tank Cover.
DP/602. Light Portable Buildings.
DP/603. Moir Pill Box.
DP/606. Semi-Portable Stove.
DP/608. Details of Table and Form.
DP/611. Squatter Latrine.
DP/612. Portable Latrine.
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DP/614. Do.
DP/615. Ablution Bench.
DP/616. Timber Framing for Tarpaulin Shelter.
DP/618. Trench Bridges.
DP/625. C.I. Bivouac Shelters.
DP/626. 15 ft. Infantry Bridge.

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DP/648.	Aston Demontable Hut.
DP/649.	Design for 6 spray bath.
DP/642.	Standard Mining Frames.
DP/663.	Orr Disinfector.
DP/801.	Nissen Huts: Hook bolts.
DP/816.	Portable Frame for Canvas Water Tanks.
DP/819.	Bath House, of light shedding.
DP/820.	Nissen Shower Baths.
DP/823.	C.C.S., Fifth Army.
DP/825/A.B.	Sausage Hutting.
DP/826/A.B.C.D.	Do. for C.C.S.
DP/828.	Brick or Concrete Hut for 44 men.
DP/829.	Sheet Iron Horse Trough.
DP/832.	Stretcher Frames.
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D.2.	Method of Destruction of Dug-outs.
D.3.	Results of Direct Hits on Gun Pits.
D.4.	Failure of Detonators and G.C. Primers.
D.5.	Salvage of Barbed Wire.
D.7.	Blowing Inclined Shafts.
D.8.	Footbridge.

APPENDIX E.

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1.	Compressed Air Pumping Plant (at W.22.A.8.0.).
2.	Disposal of Foul Water in Camps.
3.	Canvas Water Elevator Pamphlet.
4.	,, ,, ,, Sketch.
5.	Graph for Water Supply for Horses.
6.	Hasty Method of Repairing Water Main.
7.	Shipping Lists. Nissen Hospital Huts.
8.	Notes on the Operation of Corrugated Steel Bending Rollers.
9.	Quantities and Specifications for Nissen Bow Type Hospital 60 ft. × 20 ft.
10.	Water Boring Forms.
11.	Inglis Heavy Type Bridge. Safe Loads.
12.	,, Light ,, ,, ,, ,,
13.	Property Distribution Return.
14.	Arrangement for Filling Water Bottles, etc.
15.	Organization of R.E. Stores.
16.	Instructions for Working Tar Spraying Machines.
18.	Petter Engines.
19.	L.C.C. Fire Returns.
20.	Wooden Roller for Bending C.I.
21.	Report on Decauville Trucks.
22.	Notes on Possibilities of obtaining Road Metal in area Gommecourt-Cambrai-St. Quentin-Bray sur Somme.
22a	Notes on Geology.
23.	Horse Troughs.

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No. Subject.

24. Inglis Type Bridges. Description.
25. Nissen Hut. (Second Revised Specification).
26. Notes on Winter Accommodation.
27. Shipping Lists. Woodwork for Nissen Bow Hut.
28. Road Repairs.
29. Inspection of R.E. Workshops.
30. List of Current Prices (27.10.15) for Timber, Iron and Steel Work.
31. Pipe Laying.
32. Duty of L.C.C. Fire Engines.
33. Instructions for the Administration of R.E. Works in the Field.
34. Notes on Laundries.
35. List of Current Prices (November, 1916) for Timber, Iron and Steel Work.
36. Packing Instructions Steelwork Nissen Hospital Huts.
37. Armies Stocks, January, 1917. A.O.D. & R.E. Stores.
38. Moir Pill Boxes. Instructions for Erection.
39. Taking over from French, Forms.
40. R.E. Stocktaking Sheets and Circular Letter (*See* 41 for Summary of Results).
41. Notes on Field Water Supply Engineering by Fifth Army.
42. Sandbags—Prevention of Fires.
43. Instructions for Tarring Sailcloth Sheets used as Storage Tanks for Water (connects with 46).
44. Nissen Hospital Hut Pamphlet.
45. Notes on 60 c.m. Track.
46. Notes from a Lecture on Water Supply in the Field. (Fifth Army Pamphlet).

APPENDIX F.

LIST OF E.-IN-C. "D." PUBLICATIONS.

D./1 Cordite Fumes in covered M.G. Emplacements.
D./2 Method of Destroying Dug-outs to render them useless to the Enemy.
D./3 Report of Result of Direct Hits on Gun Pits.
D./4 Failure of Detonators and G.C. Primers.
D./5 Salvage of Barbed Wire.
D./6 Method of converting 2 medium screw pickets into one long and one short.
D./7 Blowing Inclined Shafts.

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,, 3. Brigade Battle Headquarters between Bernafay Wood and Longueval.
,, 4. Tunnelled Dug-outs, Mametz.

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" 8. Albrecht Mortar Emplacement.
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" 24. Brigade Command Post Near Thiepval.
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Hindenburg Line.

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[Previous articles under the heading of "The Work of the Royal Engineers during the European War, 1914—19" appeared in the *R.E. Journals* of September, 1919 (Introduction p. 105; Anti-Aircraft Searchlights, France, p. 106; Postal Section—Army Postal Services, p. 114), October (Bridging, Chapter I., p. 162), November (Bridging, Chapter II., p. 200), December (Bridging, Chapter III., p. 261), and January 1920 (Bridging, Chapter III., (*continued*), p. 13). Copies of these Journals may be obtained through the usual channels.]

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BOOKS ON ELECTRICITY.

THE following is a list of books which are recommended to officers who wish to improve their knowledge in various branches of electricity.

The list is not complete, but will be republished with additions and amendments from time to time.

Should an officer require information on any subject not included in these lists, he should write direct to the Secretary, R.E. Institute, Chatham, stating as fully as necessary what his requirements are, and every endeavour will be made to supply or procure the information.

GENERAL THEORY AND PRACTICE.

ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM.—By S. P. Thompson. Pub. Macmillan & Co. 1915. 5/6.

This book may well be looked upon as the standard " first-book " in electrical engineering. It is probably more widely used than any other book on the subject. The first edition was published nearly 40 years ago but the latest edition is as up to date as anyone could wish.

Synopsis.—Frictional Electricity. Magnetism. Current Electricity. Electrostatics. Electro magnetics. Measurement of Currents, etc. Electric Production of Heat. Electric Light. Inductance. Dynamos, Alternators and Transformers. Transmission and Distribution of Power. Electric Traction. Electro-chemistry. Telegraphy. Electric Waves. Wireless Telegraphy. Electron Theory of Electricity.

PRACTICAL ELECTRICITY.—By W. E. Ayrton and T. E. Mather. Reprinted, 1919. Published by Cassell & Co., Ltd. 10/6.

This book is described as being chiefly intended for students following a first-year lecture and laboratory course in electrical engineering. A good feature is the number of clear and often novel diagrams. The system of using mechanical analogies to explain electrical phenomena is freely used.

Synopsis.—The Electric Current and its Measurement. Magnetic Fields. Galvanometers, Electro dynamometers and Ammeters. Difference of Potential and Resistance. Galvanic Cells. Resistance : its laws and measurement. Electric Energy and Power. Quantity and Capacity. Potentiometer Measurements. Induced currents. Magnetisation of Iron.

A TEXT BOOK OF ELECTRICAL ENGINEERING.—By A. Thomälen. Translated by G. W. O. Howe. Published by Edw. Arnold. New Edition shortly.

This book bridges the gap between the elementary text books and the specialised works on various branches of electrical engineering. It deals almost exclusively with principles and does not enter into details of the practical construction of apparatus and machines. For the examination, either graphically or mathematically, of the behaviour of various electrical machines and apparatus it would be hard to find a better book. A new edition, completely re-written, is now in the press and will be published very shortly.

Synopsis of 1907 *Edition.*—Elementary Magnetism. Electro-magnetic Induction. Units. Armature Windings. Field Excitation and Commutation. Characteristics of C.C. Generators. C.C. Motors. A.C. Theory. Transformers. A.C. Generators. Synchronous Motors. Induction Motors. Commutator Motors. Converters.

ELECTRICAL ENGINEERING PRACTICE.—By J. W. Meares. E. & F. N. Spon. 1917. 25/-.

The first part of this book deals with elementary principles and the information given is accurate and precise. The second part, which treats with wiring and the domestic applications of electricity, is excellent and contains a good deal of valuable information. The third part, Electric Plant and Supply, is more variable in character, some subjects receiving scantier treatment than they deserve. On the whole it is a valuable work of reference which covers a wide field.

Synopsis.—Part I.—Explanation of Terms. Electrical Connections. Systems of Supply.

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Part II.—Electric Lighting. Domestic Applications of Electricity. Cables and their Protection. Accessories of an Electric Installation. Control and Wiring of Branch Circuits. Systems of Installing Wiring. Cost of an Electric Installation.

Part III.—Electric Driving and Motors. Plant for Private Supply. Purchase of Electrical Energy; Public Supply. Water Power. Electric Traction. Electric Road Vehicles. Electricity in Mining. Transmission of Power. Specifications; Depreciation and Maintenance. Testing.

PRACTICAL ELECTRICITY.—By Terrell Croft. Hill Publishing Co. 1917. 10/6.

This book can be recommended as a text-book on the fundamental principles of electrical engineering. Ample use is made of analogies and the illustrations are numerous and excellent. Considerable space is devoted to explaining the relation between matter and electricity, and the electron theory is widely utilized for explanations.

Sections 1—20.—Principles of Electricity and Magnetism. Sections 21—28.—Electro-magnetic Induction, Inductance, etc. Sections 29—36.—D.C. Generators. Sections 37—40.—D.C. Motors. Sections 41—52.—A.C. Principles and Machines. Section 53.—Threewire Distribution and Systems.

CONTINUOUS CURRENT ENGINEERING.—By A. Hay. Constable & Co. 7/6.

This book rather belies its title. It deals with the component parts of continuous current lighting and power plant rather than the utilization thereof in one system. It is notable for clear form of expression and straightforward reasoning.

Contents.—Electrical Units. Electromagnets. Magnetism. Hysteresis. Measuring Instruments. Dynamo Construction. Dynamo Used as Motor. Construction and Management of Motors. Secondary Cells and Their Uses. The Electric Arc. Mercury Vapour Lamps. Incandescent Lamps. Photometry. Switches. Conductors. Insulation.

ELECTRIC LIGHT AND POWER.—By E. E. Brooks and W. H. N. James. Methuen. 1919. 6/6.

This is an excellent little book, which describes in simple language and without going too deeply into theory the principles upon which the provision of electric lights and electric power depend. Some commercial application of these principles are quoted, though mainly in further explanation thereof.

Synopsis.—Lines of Magnetic Force. The Magnetic Effect of an Electric Current. The Electric Circuit. Resistance. Electro-magnetic Induction. Induction Coils and Transformers, Self-induction. Current Generators. C.C. Motors. Lighting Circuits. Lamps. Measuring Instruments. Primary Cells and Accumulators.

GENERATORS AND MOTORS.

DYNAMO-ELECTRIC MACHINERY.—By S. P. Thompson. E. and F. N. Spon. Vol. I., Continuous Current Machinery. New Edition in preparation. Vol. II., Alternating Current Machinery. 1905. £1 15s.

These can well be described as the standard works on C.C. and A.C. Machinery, dealing with all the technicalities of construction and results of actual performance.

Synopsis.—Vol. II.—Principles of Alternating Currents. Periodic Functions. Alternators. On Induced E.M.F. and Wave Forms of Alternators. Magnetic Leakage and Armature Reactions. Winding Schemes for Alternators. Design of Alternators. Compounding of Alternators. Examples of Modern Alternators. Turbo-Alternators. Synchronous Motors. Motor Generators, Converters. Parallel Running of Alternators. Transformers. Design of Transformers. Induction Motors. Design of Induction Motors. Examples of Induction Motors. Single-Phase Induction Motors. Alternating Current Commutator Motors. Standard Voltages and Frequencies.

ELECTRIC MOTORS.—By H. M. Hobart. Pitman & Sons. 1911. 21/-.

This treatise deals with Continuous, Polyphase and Single-phase Motors in an exhaustive fashion, as the synopsis of contents will show.

Contents.—Part I. *Continuous Motors.*—General Discussion of Continuous Motors. Data for Motor Designing. Types of Armature Windings. Compound-wound Series and Shunt Motors. Hopkinson Method of Motor Testing. Commutator Design. Comparative Designs for 35-H.-P. Motor. Examples of Shunt Motor Designs. Examples of Designs of Compound Motors. Interpole Motors. Variable-speed Motors. Traction Motors. Part II.—*Alternating Motors.*—Desirability of using Polyphase Electricity. Methods of Starting Induction Motors. Comparisons between Induction and Continuous Motors. Squirrel-cage and Slip-ring Induction Motors. The Design of Three-phase Induction Motors. The Circle Diagram and its Practical Applications. Torque of Induction Motors. The Circle Coefficient. Heating of Induction Motors. Calculation of Loss in Squirrel-cage Rotors. Examples of Squirrel-cage Induction Motor Design. Examples of Three-phase,

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Slip-ring Induction Motors of Small Outputs. Examples of Three-phase Induction Motor Designs, employing Wound Rotors, having Medium Outputs. Examples of Three-phase Induction Motor Designs, employing Wound Rotors, having Large Outputs. The Hunt Squirrel Cage. Variable-speed Polyphase Motor. The Design of Small Motors for Manufacture in Large Quantities. Cost and Weight Co-efficient of Induction Motors. Part III.—*Single-phase Motors.*—The Single-phase Induction Motor without a Commutator. The Single-phase Series Motor. The Repulsion Motor. Compensated Repulsion Motor. Other Single-phase Railway Motors. The Déri Repulsion Motor. Creedy's Design of an Atkinson Repulsion Motor. The Wagner Single-phase Commutator Motor. The Schüler Motor. Variable Pole Repulsion Induction Single-phase Motor. Shunt Single-phase Commutator Motor.

ALTERNATING CURRENTS.

PRACTICAL ALTERNATING CURRENTS AND ALTERNATING CURRENT TESTING.—By C. F. Smith. Sc. Pub. Co., Manchester. 8/-.

Despite the difficulty of dealing with A.C. working without using higher mathematics the author has nevertheless fulfilled his object satisfactorily and treated the subject from a practical rather than from a theoretical standpoint. Full use is made of graphical methods of explanation and vector diagrams and actual results of experiments are given in many cases in preference to generalisations.

Synopsis.—Alternating Electromotive Force and Current. Impedance. Power and Power Factor. Virtual Value of an Alternating Current. Effect of Capacity. The Transformer. Alternators. Synchronous Motors. The Polyphase Circuit. The Rotary Converter. The Polyphase Inductor Motor. Single-phase Motors. The Composition of Waves.

ALTERNATING CURRENTS IN THEORY AND PRACTICE.—By W. H. N. James. Camb. Univ. Press. 1916. 10/6.

This book is recommended because it combines an account of the laws governing the flow of Alternating Currents with a fair amount of matter on actual machines and appliances. The arrangement of the book is good and the reasoning clear.

Synopsis.—Preliminary Considerations. Inductance. The flow of Single Phase Alternating Currents in Circuits possessing Resistance, Inductance and Capacity. Power in Alternating Current Circuits. Multiphase Currents. Instruments for use on Alternating Current circuits. Alternators. Static Transformers. Induction Motors. Converting Plant. Switchgear and Protective Appliances. High Tension Transmission.

ELEMENTARY THEORY OF ALTERNATE CURRENT WORKING.—By G. L. Hall. *Electrician.* 1913. *Out of print at present.*

In the opinion of many this is quite one of the best books on the theory of alternating current. The author confines himself to theory, no mention being made of the design and construction of actual machines, but the treatment given is very simple and logical. It is essentially a common-sense book and the endeavour to "rob electrical phenomena of the mystery with which they are so often associated in the mind of the beginner" has been eminently successful.

Synopsis.—Alternating Currents. Inductance. Capacity. Resonance. Power Measurement. Polyphase Systems. Transformers. Generators. Synchronous Motors. Induction Motors. Commutator Motors.

METERS.

INDUSTRIAL ELECTRICAL MEASURING INSTRUMENTS.—By Kenelm Edgcumbe. Constable. 1918. 16/-.

As a reference book upon the recent developments in measuring instruments generally this is most comprehensive. All types of instruments are discussed and the reproduction of photographic views of instrument cases, which tell nothing, is sedulously avoided.

BATTERIES.

PRIMARY BATTERIES: THEIR THEORY, CONSTRUCTION AND USE.—By W. R. Cooper. Benn Bros., Ltd. 1917. 15/-. This may be regarded as the standard book on the subject of Primary Batteries and is a very complete work. The latest edition has a new chapter on the theory, properties and uses of selenium cells.

STORAGE BATTERY PRACTICE.—By R. Rankin. Pitman & Sons. 7/6.

A practical handbook on the manufacture and properties of electric accumulators, their installation and operation.

Synopsis.—Introductory. Manufacture. Installation and Setting to Work. Properties of Secondary Cells. Practical Working of Cells. Overhauls and Repairs. The Uses and Operations of Stationary Batteries. Batteries for Train Lighting, Vehicles and Portable Work.

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WIRING.

THE THEORY AND PRACTICE OF ELECTRIC WIRING.—By W. S. Ibbetson. E. and F. N. Spon. 1914. 6/-.

An elementary book dealing with the principles of wiring for students and wiremen generally.

Synopsis.—General Principles. Resistance. Measurement of Resistance. Ohm's Law. Filament Lamps. Arc Lamps. Distribution of Power. Instruments. Fuses, Cut-outs and Switches. Systems of Wiring. Joints, Soldering. Insulators and Cables. Batteries, Bells and Motors. Testing for Faults in Cables. Miscellaneous Wiring.

THE PRACTICE OF ELECTRICAL WIRING.—By D. S. Munro. Alabaster, Gatehouse and Kempe. 1913. 3/-.

This edition is now out of print but a new edition is in preparation. The old edition is an excellent practical book on the subject of wiring buildings, etc. for electric light. No mention is made of motors. Suitable methods of overcoming the obstacles ordinarily met with are clearly explained.

Synopsis.—Introduction. Historical. Methods of Distribution. Wires and their Insulation. Joints and Trims. Connectors and Looping. Wiring Systems. Insulator Systems. Wood Casing. Socket Systems. Screwed Tubing. Metal-sheathed Systems. Concentric Systems. Outlet and Circuit Boxes. Blocks, Grounds and Fixings. Accessories and Switching. Distributing Boards. Tools and Appliances. Wiring Plans. Procedure in Erection. Tests. Faults. Temporary and Portable Wiring. Mine Wiring. Ship Wiring. Fire and Life Risks. Specifications.

ELECTRIC WIRING, SWITCHES, FITTINGS AND LAMPS.—By W. Perren Maycock. *Electrician.* New edition shortly. 9/-.

A useful practical book for electric light engineer and wiremen.

Synopsis of 5th Edition.—Connection of Supply Mains. Distribution. Distribution Boards. Transformers and Automatic Switches. Private Dynamo-Accumulator Installations. Automatic Accumulator Switches. Switches, Ceiling Roses, Lampholders, etc. Simple Filament Lamp Circuits. Adapters, Plug Connections and Connectors. Circuits for Two-way and Intermediate Switches. Circuits for Full or Dim Lighting. Special Switches and their Uses. Detail Specifications. Metal and Carbon Filament Lamps. Lamps and Lampholder Connections for Special Purposes. Nernst Lamps. Arc Lamps. Mercury Vapour Lamps. Moore Vacuum Tube Lighting. Time Switches. Automatic Electric Signs. Electric Heating. Small Battery Charging Circuits. Motors. Systems of Wiring. Bells. Indicators. Telephones. Fire Alarms. Clocks. Tests and Testing.

DISTRIBUTION.

ELECTRIC MAINS AND DISTRIBUTING SYSTEMS.—By J. R. Dick and F. Fernie. *Electrician.* 1919. 18/-.

This is a revised edition of a book which has come to be regarded as a standard work on the subject. The requirements of the actual live engineer have not been lost sight of.

Synopsis.—Part I. *The Design of Cable Systems and the Calculation of Conductors.*—Introductory. Principles of Network Design. The Calculation of Distributors. The Association of Distributors and Feeders. The Design of Feeders. Special Types and Arrangements of Feeders. The Heating of Cables. Network Analysis. Power Networks. Three-wire Networks. Alternating and Polyphase Networks. Abnormal Pressure Rises on H.T. Alternating. E.H.T. and H.T. Systems: Supply in Bulk. Part II.—*The Installation and Maintenance of Cables and Cable Systems.*—The Construction and Properties of Cables. The Testing of Cables. Electrolysis on Underground Systems. Electric Osmose on Underground Systems. Causes of Faults—Measures for Preventing. Cable Ducts and Troughs. Choice of Cables and Methods of Laying. Laying of Cables and Ducts. Records of Mains and Allocation of Costs. Earthing, Locating Earths and Earth Indicators. Cable and Jointing Accessories. Joints, Boxes, Disconnecting Boxes and Pillars. Costs of Cables and Installation of Cables.

OVERHEAD TRANSMISSION LINES AND DISTRIBUTING CIRCUITS.—By F. Kapper. Constable & Co. 1915. 16/-.

This book explains the fundamental principles and gives the data essential to the proper carrying out of all the operations in connection with overhead distribution of electric light and power.

Synopsis.—Conductor Materials. Sag and Tension of Line. Design of Supporting Structures. Line Insulators. Wiring, including Earthing and Crossings. Erection. Surveying. Local Overhead Distributing Systems. Schedule of Prices. Regulations dealing with Erection and Operation.

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SWITCHGEAR.

ELECTRIC SWITCH AND CONTROLLING GEAR. By C. C. Garrard. *Electrician*. New edition shortly. 25/-.

This is a specialised work dealing with appliances and devices for the control and regulation of pressure and current and can be recommended as a text-book for those interested in central station supply and transmission and, in fact, to all who have dealings with electrical machines. Generally speaking the contents of the 1917 edition included Materials, Circuit-breakers, Overload and Reverse power Relays, Field Regulators, Motor Starters, Switchboards, Instrument Transformers and Protection of circuits against damage from pressure rises, both internal and external in origin.

POWER STATIONS.

LARGE ELECTRIC POWER STATIONS: THEIR DESIGN AND CONSTRUCTION.—By Dr. G. Klingenberg. Crosby Lockwood & Son. 1917. 25/-.

Up-to-date works on power stations are notoriously difficult to come by, for the, reason that the trend of design is continually changing. In half of this book, however the author treats the subject from a general point of view in an able and instructive manner; the other half of the book is devoted to descriptions of particular stations.

POWER HOUSE DESIGN.—By J. F. C. Snell. Longmans, Green & Co. 1911. 22/6.

This book deals with the complete design of electric power stations and consists principally of the collection and classification of the experience of the author and other eminent engineers.

Synopsis.—General Principles of Power House Design. Choice of Site, Type of Plant. Buildings. Steam raising Plant. Steam and Feed Pipe Systems. Steam-driven Prime Movers. Condensers, Cooling Towers, Air Pumps, etc. Gas and Oil Engines. Hydro-electric Stations. Switchgear. Practical notes on Generators, Motors, Boosters, Transformers, etc. Small Power Houses and Sub-stations.

TESTING.

HANDBOOK OF ELECTRICAL TESTING.—By H. R. Kempe. E. and F. N. Spon. 1908. 25/-.

This is a standard book on the subject of testing and its popularity can be judged from the fact that the present is the seventh edition. It will be noticed that machine testing is not included.

Synopsis.—Simple Testing. Resistance Coil. Galvanometers. Shunts. Measurement of Galvanometer Resistance. Measurement of the Internal Resistance of Batteries. The Wheatstone Bridge. Localization of Faults. Keys, Switches, Condensers, and Batteries. Measurement of Potential. Measurement of Current Strength. Measurement of Electrostatic Capacity. The Thomson Quadrant Electrometer. Measurement of High Resistances. Measurement of Resistances by Potentials. Localization of Faults by Fall of Potentials. Tests during the Laying of a Cable. Joint Testing. Specific Measurements. Correction for Temperature. Localization of Faults of High Resistance. Localization of a Disconnexion Fault in a Cable. A Method of Localizing Earth Faults in Cables. Galvanometer Resistance. Specification for Manufacture of Cable. System of Testing Cable during Manufacture. Appendix. Tables.

PRACTICAL TESTING OF DYNAMOS AND MOTORS.—By C. F. Smith. Sc. Pub. Coy. Manchester. 6/6.

This is an excellent practical book, with good diagrams and numerous curves taken from actual tests, though continuous current dynamo machinery only is dealt with.

Synopsis.—General Purpose of Tests. Measurement of Armature and Field Resistances. Production of Electromotive Force in a Dynamo. The Magnetic Circuit. Armature Reactions. Shunt-wound Dynamo. Series Dynamo. Compound Dynamo. Effect of Current in the Motor Armature. Efficiency Tests of a Motor. Efficiency Tests of a Dynamo. Miscellaneous Tests. Motor Generators and Boosters.

HANDBOOKS.

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS.—By F. F Fowle. Hill Publishing Co. Dec. 1915. 30/-.

This book is the joint production of over 60 leading Engineers. There are 95 sections with the subject matter grouped so that you can find all the material on a given subject in one section. Every subject is fully and carefully indexed.

Contents.—Units, etc. Electric and Magnetic Circuits. Measurements and Measuring Apparatus. Properties of Materials. Magnets, Induction Coils, Condensers and Resistors. Transformers and Rectifiers. A.C. Generators and Motors. D.C. Generators and Motors. Convertors and Double Current Generators. Power Plants. Power Transmission. Distribution Systems. Interior Wiring. Illumination.

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Application of Motors. Electric Railways. Electric Commercial Vehicles. Electric Ship Propulsion. Electro-chemistry. Batteries. Telephony, Telegraphy, and Radio-Telegraphy. Miscellaneous Applications. Mechanical Section. Standardization Rules (American). Engineering and Central Station Economics.

GLOVER'S VADE MECUM.—W. T. Glover & Co. 1918. 12/6.

A very useful little book. Giving full details of cables and their employment for overhead and underground distribution of electrical energy.

Synopsis.—Manufacture of Cables. Cable Laying and Cable Jointing. Colliery Cables. Overhead Lines. Maintenance and Testing. Useful data and formulæ. Regulations governing Installation and Supply of Electricity.

FOWLER'S ELECTRICAL ENGINEERS' POCKET BOOK.—Sc. Pub. Coy. Manchester. 3/-.

A highly useful compendium at a remarkably low price.

Synopsis.—Electrical Units. Magnets and Magnetic Data. Physical Properties of Metals. Conductors. Insulating Materials. Electric Lighting. Electric Welding. Comparison and Measurement of Resistances. Testing Sets. Electrical Measuring Instruments. Electricity Meters. Electro-Plating. Primary Batteries. Secondary Batteries. The Dynamo and Motor. Testing Dynamos and Motors. Power and Efficiency of Motors. Management of Dynamos. Alternate Electric Currents. Polyphase Alternating Currents. Alternate Current Machines. Transformers. Alternate Current Motors. Switchboards. Circuit Breakers and Lightning Arresters. Electrical Power Distribution. Rotary Converters. Electric Traction. Electrical Power Plant. Board of Trade and other Rules and Regulations, with Numerous Tables, etc.

ELECTRICAL TABLES AND MEMORANDA.—By S. P. Thompson. E. and F. N. Spon. 1919. 2/-.

A waistcoat-pocket book which is truly a *multum in parvo*. As a "pocket memory" it is most useful.

Contents.—Electrical Units. Primary Batteries. Accumulators. Circuits and Conductors. Losses in Cables. Insulating Materials. House Wiring. Underground Cables. Aerial Conductors. Measuring Instruments. Electro-metallurgy. Arc Lamps. Incandescent Lamps. Vapour Lamps. Illumination. Domestic Applications. Cost of Electrical Energy. Institution of Electrical Engineers' Wiring Rules. Care of Installations. Magnetic Units. Magnetic Properties of Iron and Steel. Energy Loss by Hysteresis. Law of Magnetic Circuit. Winding of Electromagnets. Permanent Magnets. Continuous-current Motors. Alternating Currents. Power in Alternating-current Circuits. Tables of Wire Gauges. Conversion Factors. Mathematical Tables. Index.

(Copies of these books are being placed in the R.E. Corps Library.—ED., *R.E.J.*)

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REVIEWS.

THE DEFEAT OF AUSTRIA AS SEEN BY THE 7TH DIVISION.

By THE REV. E. C. CROSSE, D.S.O., M.C. (H. F. W. Deane & Sons. The Year Book Press Ltd.). Price 7/6.

This is an extremely interesting account of the final operations of the 7th Division in Italy in the last days of October 1918, and includes descriptions of the crossing of the Piave at Papadopoli Island, the bridging of the river, and the final rout of the Austrians at the Tagliamento. As Major General T. H. Shoubridge says in the Foreword, the book will rank as history as far as the incidents it describes, and yet it is not dry history, and the pill, if it is a pill, is well gilded. The chapter on the Building of the Bridge will be read with interest by Royal Engineers, and if ample credit is given to the excellence of the equipment and to the skill of the Italian *pontieri* who placed four pontoons in the worst part of the stream, the good work done by the 95th and 54th Field Companies R.E., under Majors Clifford and Boulnois, with the assistance of engineers from the 23rd Division and the XIV Corps, is fully recognised. In places the author is at fault in his compass-points, as for instance on pages 36 and 37 in describing the capture of the Island, but the excellence of his maps leaves no opening for misunderstanding the details of the fighting. The book is abundantly illustrated.

F.E.G.S.

STIRRING DEEDS IN THE GREAT WAR.

By CHARLES E. PEARCE. (Stanley Paul & Co. 6/-.)

An attractive collection of war yarns which would be appreciated by the younger generation.

F.E.G.S.

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NOTICES OF MAGAZINES.

JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA.

In the number of this *Journal* for October 1919 there appears an article by Major C. F. Stoehr R.E. on the subject of the Future Organization and Training of the Sappers and Miners. Major Stoehr points out that although the Sappers and Miners during the Great War have shewn by their services in France, East Africa, Mesopotamia, Egypt, and Palestine that their peace-time organization and training were fundamentally sound, yet some weak points have come to notice, the principal of which appear to be :—

(1) The absence of an efficient reserve, a defect which they share with the whole Indian Army ;

(2) Scarcity of Officers who know anything of a Sapper and Miner Company, with which may be coupled lack of sufficient technical engineering knowledge on the part of S. and M. officers and also the probability that the C.R.E. of a Division will either have little or no knowledge of the units under him, or will not be in a position to deal as efficiently as he might with the engineering problems which he will have to solve ;

(3) Failure of the staff to get the best use out of S. and M. Companies, these two last defects showing lack of touch between S. and M. and other R.E. officers and between S. and M. and the staff ; and

(4) Necessity of reconsidering the data on which the transport and equipment of a company have been based.

As a remedy for (2) he proposes that every officer should spend his first year in India in Military Works and his second year in Sappers and Miners. He would then learn the routine of Military Works and study the language in a post where it is not essential, while his second year would enable him to drop into his place at once if subsequently from other work he should be attached to a S. and M. Company for active service.

If after his second year he decided to make his career in Sappers and Miners, he should be allowed to remain with them for another five years and should then be sent to Military Works, preferably on the frontier, for two years or until he should be appointed to command a Company. He should also spend another two years on Military Works before obtaining the appointment of Superintendent of Park or of Instruction.

As regards the third defect no Division in India in peace-time should be without three Sapper and Miner Companies and a headquarters of Divisional Engineers. But the detachment of such a large number of companies would be difficult to reconcile with the continued existence of the three Corps of Indian Sappers, whose retention is desirable from the point of view of sentiment and *esprit de corps*.

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But would not the three Corps organization still be necessary for the training of officers and especially of the men? As Major Stoehr says, very nearly all sappers are taken from the plough. The training of artificers is a matter of years, and it is doubtful if it could be done efficiently at a Divisional Engineer headquarters. Major Stoehr suggests that it can. Otherwise it should not be difficult to graft a Divisional Engineer system on to the existing organization of C.R.E's and A.C.R.E's.

On the subject of transport and equipment, it is a question whether in view of the greater weight of equipment of all sorts which now accompanies an Army, and the enormous development of motor transport, operations on the frontier will not in future have a wheeled road for at least their main line of communication, and whether a large proportion of the equipment of S. and M. Companies should not in future be carried on carts.

F.E.G.S.

THE MILITÄR-WOCHENBLATT.

November, 1919.

The efforts to keep up the old army spirit and to maintain the old status of the officer class are very evident in the November numbers. Courts of honour, it is proposed, should be kept up; the old uniform will not disappear as it may be worn by retired officers. The formation of Regimental Unions goes on gaily. The latest excuse for the loss of the war is that Germany did not raise and train in peace as many men as she could have done. This was not the fault of the General Staff but of the Reichstag and particularly of the Left.

No. 54.

The Miracle of the Marne.—This is mainly a review of General Baumgarten-Crusius' work on the battle of the Marne (reviewed in *The Times Literary Supplement* of 13th November, 1919), in which so many secrets were revealed, particularly the mysterious part played by Lt.-Colonel Hentsch, the emissary from O.H.L., in ordering the retreat. The article quotes from Helfferich's account of his impressions at O.H.L. on the 4th September. The Kaiser said to him "This is the 35th day after mobilization; Rheims is in our possession, the French Government has gone to Bordeaux and our cavalry is 30 miles from Paris." On the other hand von Moltke was anxious and depressed. He said "We have been successful but have not yet won, we have hardly a horse that can go out of a walk. Don't let us deceive ourselves. Victory means annihilation of the enemy's power of resistance. When millions face millions, a victor has lots of prisoners. Where are ours? We got some 20,000 in the Lorraine battles, 10,000 here and another 20,000 there perhaps. The relatively small number of captured guns also show me that the French have retired according to plan and in good order. The hardest task is still in front of us." The Germans now endeavour to

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make out that the retreat from the Marne was the mistake of a junior officer or due to von Moltke's weakness. Those who believe in Providence will be more inclined to say that a lying spirit was put into the mouths of the Kaiser's advisers, and that the German defeat was indeed a miracle.

Where is Tradition?—A wail that German officers now attack and throw mud at each other in the public press, and appeals to them to make up their differences and show the united front of pre-war days.

The One-Year-Volunteer Certificate as a Factor in Education.—A regret the incentive to work at school, and obtain the certificate that entitled the holder to present himself for service as a one-year-volunteer, has been removed by the abolition of compulsory service.

End of Bestowal of Decorations for the Campaign 1914-18.—An official notice states that no recommendation will be accepted after the 30th November, 1919.

No. 55.

Causes of the German Capitulation of 11th November, 1918.—Reviews a book by a Colonel Schwertfeger which endeavours to disprove the statements in the French General Staff pamphlet describing the desperate state of the German Western Armies in November, 1918. Colonel S's point seems to be that we should only regard the German army as it was on the 5th October, 1918, when an armistice was asked for, and that the disasters which overtook it between that date and 11th November, and the others that were awaiting it should not be taken into account!

The Military-Political Events in Russia (Middle of September to Middle of October).—A useful summary, continued in the next number.

Cyclist Units for the National Army advocates that as much as possible of the small army allowed to Germany by the Peace Treaty should be put on wheels.

Roll of Honour.—Dragoon Regiment No. 13: 31 officers and 289 other ranks killed. Guard Pioneer Battalion: 59 officers, 208 N.C.O.'s and 1147 men killed. The battalion was disbanded on 14th April, 1919.

No. 56.

The Military-Political World Situation.—The ratification of the peace terms is not expected before January or February. It is insinuated that it suits England and France best to keep the indeterminate stage between peace and war open as long as possible.

The New Polish Army.—The increasing importance of the new Polish army is pointed out; and it is asserted that it consists of 550,000 men with up-to-date material. Prussia only kept 15,000 men in Posen province, in the portion of it occupied by Poland there are 60,000 to 70,000.

Gazette.—This contains the new heading "Appointments in the New Army (200,000 men strong)."

Roll of Honour.—The Staff of the Cadet School at Köslin: 10 officers killed.

No. 57.

Promotion and Brevet Promotion of Officers.—This combats an article in the *Kreuz-Zeitung* that argued that officers who accepted promotion

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from the New Government thereby lost their claim to be considered " Royal Prussian officers."

Regimental Unions of the Old Army.—The formation of these useful nuclei goes on merrily. There are now 72. The names and addresses of the officer " who represents the interests of the unit " are given.

Field Marshal Graf Haeseler in the War.—Some anecdotes. It is related that at the passage of the Meuse at Sivry, 1st September, 1914, he sat on a chair at the bridge under artillery fire to steady the troops, who were not crossing as they should.

Roll of Honour.—Jäger Battalion No. 4. This battalion formed one field, one Ersatz and two Reserve battalions and 3 cyclists companies: 80 officers and nearly 2700 other ranks killed.

No. 58.

Voluntary Courts of Honour for Officers.—The National Assembly has abolished the old courts of honour (which settled cases in which an officer's honour was engaged, ordered duels, etc.) and suggests that they should be kept up voluntarily to maintain the status of the officer caste.

The Economical Position of Officers.—The old allowances given to assist officers on retirement to start in civil life have apparently been abolished.

Field Marshal Graf Haeseler.—Further anecdotes. On one occasion he said " What more can a man want than drill on the barrack square: he has fresh air and exercise."

Diary of the War.—This is continued to the 11th November " when in consequence of the signing of the armistice hostilities cease." The entries during November only speak of a withdrawal according to plan: the enemy either ' is repulsed ' or ' follows.'

No. 59.

Article 104 of the Constitution of the Reich.—A Protest against the proposed new article of the Constitution that Military law shall not be applicable except in time of war and on board ships of war.

General Field Marshal Count von Haeseler on the World War.—An extract from Baron Eckardstein's memoirs is quoted which gives an account of his visit to Haeseler at Stenay on September, 1914. The old gentleman was in an attic surrounded with maps. He protested against the silly attitude of the German Press which was lying to the people about successes and assuring them that the French power of resistance was broken.

Contributions to the history of the War.—Extracts from the French *Journal Official* and *L'Echo de Paris* with regard to the secret sittings of the Chamber. In June, 1916, General Roques, the Minister of War, gave the following figures of the strength of the French armies.

August, 1914	1,900,000
1st January, 1915	2,309,000
1st July, 1915	2,665,000
1st January, 1916	2,728,000
1st May, 1916	2,753,000

Of the last total 2,632,000 were with the Armies in France. There were 121,000 with the Army of the Orient, and 308,000 in Algeria and Morocco.

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No. 60.

Czernin's Recollections.—A review of Count Czernin's book in which are extracted all the phrases which might be interpreted to show that Austro-Hungary was not true to Germany. "There is not a hint that we continuously protected Hungary from Russian invasion by *German battalions*, which supported the always wavering (often deserting) Austrians."

The Supreme Command and its Most Important Decisions 1914-1916.—A Review of General von Falkenhayn's work in form of a summary. It does not bring out that Falkenhayn describes the successes in Russia at great length and slurs over Verdun and the Somme in a few pages, which bristle with the most transparent inaccuracies.

Roll of Honour.—Dragoon Regiment No. 1: 19 officers and about 100 other ranks killed. Field Artillery Regt. No. 66: 50 officers killed.

No. 61.

The Supreme Command and its Most Important Decisions 1914—1916.—Review continued. The review does not consider that Falkenhayn who was an ardent advocate of the Balkan campaign should be blamed for its "sad results."

The Guilt for the Loss of the War.—By Major General Von Kurnatowski, who combats the speech of a Free Conservative Member of the Reichstag in which he stated that the military leaders were partly responsible for the loss of the war. He insists that it was the shortsightedness of the Social Democrat members who refused in peace time the additional troops and war material for which the General Staff asked.

No. 62.

Distribution and Garrisons of the Reichswehr Troops.—This gives in tabular form the order of battle so far as it is formed, of the Berlin, Cassel, Kolberg and Munich Reichwehr-Gruppen Kommandos, a long word which camouflages Army Corps. Wehrkreis Kommando similarly conceals a division.

The new Army is organized in composite brigades; each brigade consists of

3 Infantry Regiments (see below)
1 Cyclist Co.
2 Cavalry Regiments
1 Light Artillery Regiment
1 Pioneer Battalion
1 Signal Section
1 Motor Transport Section
1 Medical Company

An infantry regiment consists of three or four battalions, a trench mortar company, a signal company, one or two machine gun companies, and an infantry gun battery.

A cavalry regiment has three squadrons and a machine gun squadron.

A light artillery regiment has three brigades and a trench mortar battery.

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A pioneer battalion has two companies, a searchlight section and bridging train.

A signal section contains telephone, pigeon and listening subsections.

Uniform.—The old uniform will not disappear as officers on retirement are being given the right to wear it.

No. 63.

Reinforcement of the Army before the War.—General-Colonel von Heeringen a former War Minister has been writing to the *Kreuz Zeitung* to show that Germany lost the war because she did not make sufficient preparations and increase her army from 1909 onwards as it was in her power to do.

The obstacles were that the State Secretary of the Imperial Treasury Herr Wermoth opposed non-productive expenditure and that when he was got rid of in 1912, von Tirpitz competed for any money available and von Moltke didn't press enough. The War Office never opposed increase, it was the civilian treasury officials who lost the war because they would not agree to three more army corps.

Inquiry Commission of the Reichstag.—The instructions sent to and the doings of Count Bernstorff, the German Ambassador at Washington, it is suggested, might be made a subject of enquiry. He was completely deceived by President Wilson. It is hinted that he saw rather with the eyes of his American wife than with his own. She must therefore be placed high among the causes of the German defeat.

Field Marshal Count Haeseler as the Trainer of the German Army.—An absurd article. The old man has little claim to fame except a slight physical resemblance to von Moltke the elder and a military manner of a now obsolete type, which combined offensive curiosity with the manners of a drill serjeant.

O.H.L. and its most important decisions 1914-16 continued.

Roll of Honour.—Pioneer Battalion No. 3: 62 officers and over 1,000 other ranks killed. Two officers died of sickness.

No 64.

Dr. Theodor Toeche-Mittler.—Obituary notice of the head of the firm which publishes the *M.W.B.* He died on 24 November, 1919, aged 83.

Further Awards of the Long Service and Good Conduct Cross.—This is not one of the decorations to be abolished.

The Economical Position of Officers.—Notice that employment in the 200,000 strong New Army does not give right without question to allowances, or a claim to employment in the 100,000 strong Reichswehr, when peace is ratified.

The Next Three Wars.—Review of a book which prophesies that England having attacked and defeated Germany will in turn attack Japan, France and U.S.A.! The reviewer finds it cheering and a pleasant change from prevailing pessimism; he will hardly live long enough to see the fulfilment of his wishes.

No. 65.

The World Military-Political Situation.—This gives the proposed new peace organization of the French Army, viz. 350,000 men. Of this

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total 200,000 are one-year service men; 30,000 N.C.O's; 20,000 Colonial troops in France; 50,000 volunteers and re-engaged men; 50,000 foreigners and natives of North Africa.

The writer warns against hopes of a possible disagreement between France and England, "robbers often fight over the spoil, but it hasn't come to this yet." He further warns against expectations from the delay of the U.S.A. in ratifying the Peace treaty. "Americans are business men and that only. . . . and they are creating a stronger army than they have ever had: 350,000 men perhaps 500,000."

Military-Political Events in Russia.—The blame for the continuance of Bolshevism is thrown on England, who is engaged on only English not anti-Bolshevic policy.

Roll of Honour.—Foot Artillery Regiment No. 8: 27 officers, 63 N.C.O's and 412 other ranks killed. Infantry Regiment No. 459 formed in January 1917): 38 officers and 1180 other ranks killed.

J. E. EDMONDS.

REVUE MILITAIRE GÉNÉRALE.

August—September, 1919.

It is announced, in an editorial note, that General de Lacroix has resigned the post of Editor-in-Chief. In view of this fact the Management of the *Revue Militaire Générale* has decided to abandon its former policy and to make a start on fresh lines by making the columns of the publication a *tribune libre*.

Communications dealing with matters relating to the Great War are invited. The importance of obtaining a correct record of events, whilst details are fresh in the minds of the participants in episodes of historical interest, is recognised; hence the change in policy announced. The hope is expressed that contributions to the pages of the *Revue* will be of a nature to assist the General Staff in revising the regulations, and that they will prove, at the same time, of value from the standpoint of military history.

THE GERMAN ARMY BEFORE AND DURING THE GREAT WAR (1914–1918).

M. Camena d'Almeida, the author of the original article, has drawn largely for his material on the diaries of German officers and non-commissioned officers. The part of the article appearing in the number of the *Revue* under notice is devoted to the mobilization of the German Army.

Preparatory measures.—M. d'Almeida deals under this head with the steps taken in Germany to secure a secret mobilization of her army so that her preparations might be complete even before she proclaimed the intermediate state of existence between Peace and War, labelled "*der Zustand der drohenden Kriegsgefahr*" (the state of threatened War danger).

Some weeks before the proclamation was issued declaring a "state

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of threatened War danger," reservists had received summonses calling them up for training for a period of 56 days, commencing on the 1st August. These notices were not dated, but evidence exists which indicates that they must have been sent out, at least, as early as the first days of July.

Although the " state of threatened War danger " was not proclaimed in Germany until the 31st July, entries in the diaries of German officers and non-commissioned officers prove conclusively that mobilization was in full progress, at least, as early as the 28th July. The German people appear to have had an inkling at this time that the authorities of the Wilhelmstrasse had irrevocably decided in favour of War; this conclusion is to be drawn from the fact that, on the 27th July, the Socialist party placarded Berlin with flaming posters denouncing warlike measures and calling a meeting for the following day to raise a protest against the Austrian ultimatum to Serbia. The police, naturally, took steps to prevent the masses obtaining access to the central quarters of Berlin; but huge crowds managed to assemble on the 28th July in the *Unter den Linden* and marched through this thoroughfare shouting: " Down with War! Down with Austria! Long live Peace! Long live the Republic! "

It was on the 27th July also that the ex-Kaiser, on his return from the Norwegian Fjords, arrived in Potsdam. The German public appears in no way to have been taken by surprise when, at noon on the 31st July, the proclamation announcing the " state of threatened War danger " was read at the *Zeughaus*, Berlin, by an officer of the 1st Regiment of Grenadier Guards.

" *The State of threatened War danger.*"—The general mobilization of the German Army was begun under the mask of the situation created by proclaiming a " state of threatened war danger." The evidence available shows that regiments on the frontier received their full complements of reservists by the 31st July; military guards were placed on certain important railways on the date last mentioned; battalions of the Landsturm began to be formed on the evening of the 31st July and eventually took over the guarding of the railways on the frontier from the regular troops on the 2nd August.

In order to excite indignation in the people, false reports were duly spread in the German Press. Two telegrams were published in Berlin with this object in view on the morning of the 31st July: in one of them it was stated that the Russians had crossed into E. Prussia; and in the other, it was announced that Russian patrols had advanced as far as Jarotschin, in the province of Posen, and had blown up the railway there. Similar reports were published in relation to the western frontier of Germany. The *Lokal Anzeiger* went so far as to make a premature announcement to the effect that a general mobilization had been ordered; this was probably done in accordance with a premeditated plan and with the design of testing the temper of the people. The die having been cast, the Brandenburg flag was hoisted, at noon on the 1st August, at the Royal Palace, and officers of the General Staff began at once to rush through the streets of Berlin in motor-cars informing the people that the orders for mobilization had been issued.—(*To be continued.*)

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THE VERSAILLES TREATY OF PEACE AND MILITARY SERVICE.

General Thevenet is the author of the original article. He points out that the Treaty of Peace signed at Versailles on the 28th June, 1919 imposes on Germany conditions of a political, economic, and military nature which are dictated by a desire to put an end for ever to German Imperialism and to render possible the inauguration of a durable peace, the pressing necessity for which is felt throughout the entire world.

Among the military clauses of the Treaty is one which forbids Germany from and after the 31st March 1920 to maintain an army of more than 100,000 men; these men are to be enlisted voluntarily for long service. At the same time, her armaments and the manufacture of war material are strictly limited; conscription is abolished; her military frontier is fixed at a distance of 50 kilometres E. of the Rhine, with a prohibition against the construction and maintenance of fortifications and the assembly, maintenance or movement of armed forces within the neutral zone so created. Finally, in order to ensure the execution by Germany of the terms of the Treaty, troops belonging to the Allied and Associated Powers are to remain in occupation of the E. bank of the Rhine for a period of 15 years.

Although the responsibility for enforcing the terms of the Treaty and respect for the provisions of international law rests with the League of Nations, nevertheless, in view of the peculiar dangers to which France would be exposed in the event of non-observance by Germany of the conditions imposed upon her, Great Britain and the United States of America have entered into special treaties with France undertaking to render her immediate assistance in the event of an unprovoked aggression on the part of Germany.

The Treaty has given rise to considerable discussion and it is evident that many Frenchmen feel that no adequate security against a repetition of the experiences which France has had to undergo in the Great War is afforded under its terms. General Thevenet points out that although Germany has been beaten, and is for the time being precluded from doing any further mischief, yet it would be under-estimating her vitality, energy, and power of organization to assume that she will willingly remain a docile tributary of her conquerors for long. Attention is called to statements recently made by the Prussian Home Secretary and to views expressed in the *Zeit*, which clearly indicate that Germany intends at the earliest moment to tear the Treaty of June 1919 to shreds.

General Thevenet calls attention to the fact that the creation of the neutral zone on the E. bank of the Rhine should, in the case of an aggression on the part of Germany, afford France *time* and *space*: *time* in which to prepare defences against the passage of the river, thus securing her against surprise and permitting the employment of adequate forces to oppose a German advance; *space*, should the river be crossed, to enable her to engage the enemy in his own territory and thus to preserve France from the horrors of an invasion.

It is urged that France should at all times permanently maintain on the frontier a strong force capable of meeting all eventualities. The time for *levées en masse* are, it is pointed out, past. Improvised armies, insufficiently provided with engines of war, etc., merely invite disaster. General Thevenet estimates that, by taking proper steps, sufficient men

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can be trained in France to provide a national army of from 5 to 6 million men, who could be easily mobilised and held in immediate readiness to ward off any attack. He considers compulsory military service to be indispensable and suggests that, if it is applied methodically, it can be made to play an important rôle in the civic instruction of the rising generation. In December 1918, Mr. Daniels, Secretary to the Navy, made a somewhat similar statement regarding the rôle of the American Navy; the text of this statement is quoted in the original article.

General Thevenet in conclusion states that, only by the signatories to the Treaty of Versailles working harmoniously together, will it be possible to render its provisions effective and durable. He recognises that it is necessary for France to diminish her military expenditure; but, in his opinion, compulsory military service must be maintained by her, as being one of the surest guarantees for the peace of the world.

Man the Instrument of War.

Lieut. Col. Lucas, the author of the original article, points out in an introductory section to his article that although much has been already published relating to the splendid work of the *poilus* during the Great War, much more has still to be written. No one, who has not lived with the French Army can, he says, possibly understand the immensity of the sacrifice the *poilu* has made for his native land. He wishes his paper to be regarded merely as an introduction to the study of the infantry soldier as an instrument of war.

Know thy man should, he states, be borne in mind as a first axiom by every chief, senior or junior, who may be called upon to take command of a unit, or sub-unit, of infantry. Before a man can properly handle a tool, he must know all about it; so is it the case with that most highly developed and the most delicate of instruments in the world, the infantryman, his peculiarities must be learnt before he can be successfully handled.

Col. Lucas points out that the basis of all study of the infantry combat *is experiment*; both that of peace manœuvres as well as that resulting from observations made in the course of a war. He examines the views on this subject expressed by such well known writers as General Moraud and Colonel Ardant Du Picq; many extracts from whose writings appear in the original article.

The question of the training of the infantry soldier is dealt with at some length in the original article. Col. Lucas treats the subject under five heads:—

1. The main characteristics of modern combats.
2. The *morale* of the combatant.
3. The good and bad points in the French soldier.
4. The influence of organization and military training.
5. Conclusion.

The article does not lend itself readily to condensation. Col. Lucas shows that the constant pre-occupation of all great commanders has been the study of the characteristics and temperament of the troops that they have been called upon to lead in war, and he urges that in view

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of the importance of the subject steps should be taken to provide special instruction on the psychology of the soldier in all courses for officers and non-commissioned officers, so as to enable them to acquire a correct appreciation of the qualities of the man and his mentality, since this is the foundation upon which all military training must rest.

JOTTINGS.

The Peace Treaty is briefly discussed. It is pointed out that the statesmen charged with the duty of liquidating the situation created by the Great War had two solutions of the problem before them: one, that of rendering Germany harmless by carving her up; and the other, that of maintaining Germany in a sufficiently strong position such as to render her capable by the labour of her people to pay off to her conquerors the enormous liabilities created by her conduct. It is the second of these solutions that has been accepted. Germany remains a united nation of 70 million souls and she has not renounced her intention of annexing German Austria.

Some perturbation has been caused in France owing to the attitude of the British Government in relation to Syria; and at the same time, anxiety has been caused owing to the refusal of the American Senate to ratify the Peace Treaty.

Reference is made to the energetic action taken by the Entente in securing the abandonment of Article 61 of the new German Constitution, whereby it was intended to annex Austria out and out to the German Empire.

Russia, it is pointed out, remains the great unknown quantity in the reconstructed world. The situation there affords a fine field of action to French politicians and diplomats, but one containing many pit-falls.

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Short notices are published of Fernand Engerand's *Le Secret de la Frontière* (1815—1871—1914), *Charleroi* and of Jean Fleurier's *Mon Sac*.

A summary is given of the titles of articles of interest appearing in foreign military periodicals, and the appropriate references.

W. A. J. O'MEARA.

REVUE MILITAIRE SUISSE.

No. 11.—*November*, 1919.

ARTILLERY SIGHTS.

The original article is based on an interview with Colonel C. Dapples of Lausanne, the inventor of the metric system of graduating artillery sights, the so-called *millième de l'artilleur*. This system of graduating artillery sights was first introduced in Switzerland in 1864; it consists in taking the length of the line of sight, whatever it may be, as a *unit*, and in graduating the tangent-sight so that its divisions represent $\frac{1}{1000}$ths

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of this *unit, i.e.*, divisions, which up to a range of 3,000 paces, represent the *natural tangent* of the angles of elevation. Prior to the War the *millième* had been accepted in practically every country, except Great Britain, as the basis for graduating artillery sights. The Americans adopted the *millième* in 1908, but it wanted the Great War to move the British to surrender their traditional method of marking artillery sights in degrees and in parts of an inch. To-day, the same method is employed throughout the world for graduating artillery sights, much to the satisfaction of the inventor of the artilleryman's *millième*.

Notes and News.

Switzerland.—In France, Germany and in other parts of the world the reorganization of the national armies is now far advanced. It seems to be anticipated that some way round will be found in Germany for evading the spirit of the Peace Treaty, although its terms may be observed to the letter. The view prevails that conscription will be retained in the French Army; opinions are divided as to what shall be the period of colour service. Proposals as to the length of colour service vary from 8 to 12 months; it is probable that the latter period will eventually be decided upon. Owing to the elections the question of army reorganization has been abeyance in Italy; it is expected that the duration of colour service will be shortened considerably. Austria has, from the military point of view, ceased to exist; only in the Czech and Slav States are there armed forces. In Switzerland, the General Staff is still engaged on the question of army re-organization; it is thought that no changes of a fundamental character will be made. The vote for the Swiss Army, which was 45 million francs before the War, has been fixed at 50 million francs for 1920; in view of the difference in the buying power of the franc, the larger vote represents by comparison a reduction of 45% on pre-war military expenditure.

The question of Switzerland joining the League of Nations was proposed at a reunion of the students of the *Helvétia*. After discussion the vote was taken and a resolution carried in favour of Switzerland becoming a member of the League.

The present Swiss War Minister will shortly be retiring from office; his successor is not yet named. Colonel Bridel is to replace Colonel Kunz as Director General of Artillery.

It would appear that Germany is intriguing to establish herself in the Vorarlberg, an intensive German propaganda has been launched in this region. Further, the Deutsche Bank is negotiating the purchase of the water-power of the Upper Rhine on behalf of the A.E.G.

Portugal.—A special correspondent states that the issue of a White Book dealing with matters connected with the War is daily expected. He states that Portugal maintained an Army 50,000 strong in France, and at the same time sent 34,600 European troops to the two Africas; 19,500 native soldiers and auxiliaries were also maintained in the latter regions. The Portuguese casualties in France amounted to 14,623 officers and men, equivalent to about 27% of the Portuguese Army in that country; whilst the casualties in Africa are estimated at 21,000 officers and men, equivalent to 40% of the Portuguese force employed

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in the Southern Continent. The Portuguese shipping sunk by the Germans amounted to 96,379 tons. Portugal expects to be rewarded for the part she played in the War by a rectification of the N. frontier of Mozambique, the restitution of Kionga and an indemnity to cover her War expenditure.

It is suggested that a small hamlet, with examples of Portuguese architecture, should be specially laid out as a Portuguese War Memorial in Flanders and that a site should likewise be dedicated to Portugal in France, in the region where Portuguese soldiers fought and died in the War for European Liberty and Civilization.

INFORMATION.

A strong Committee has been formed in connection with the continuance of the *Revue* during 1920. There seems to be a good prospect of sufficient support being obtained to justify the publication of this paper during next year.

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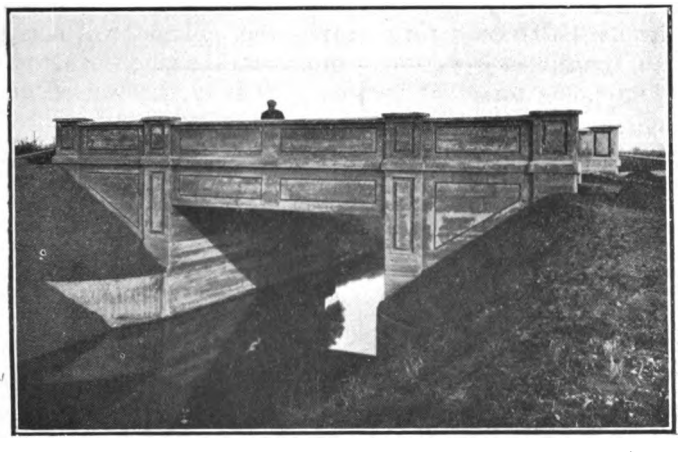

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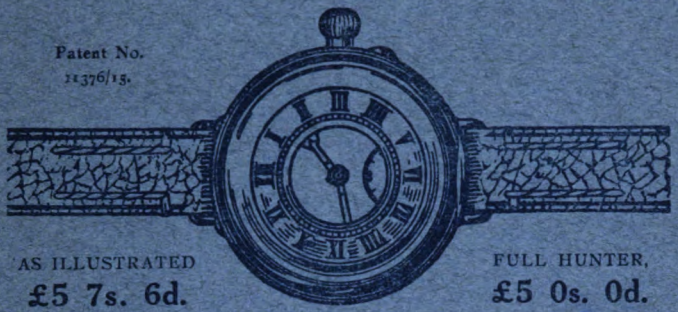

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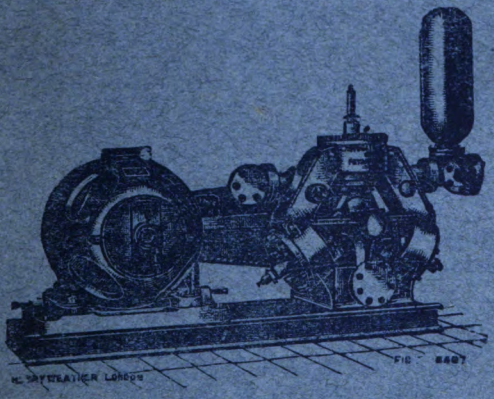

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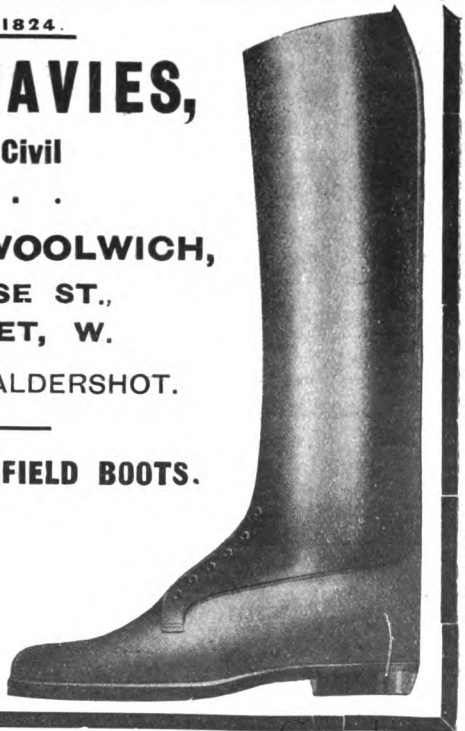

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MONTGOMERIE PRIZE.

ATTENTION is invited to the conditions under which this prize, in value about £10, is offered for competition each year.

1. The Prize shall be awarded by the R.E. Institute Council in the manner considered best for the encouragement of contributions on professional subjects, by R.E. Officers, to the Corps publications. From the beginning of 1920 it has been decided that the Prize shall be confined to Officers on the Active List not above the rank of Substantive Major.

2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography, or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

3. The name of the recipient of the Prize shall be notified in the Corps publications; and copies of the contribution for which the Prize was awarded shall be presented to the representatives of the donors.

The following are suggested as subjects for contributions :—

(*a*). Descriptions of works actually carried out in peace or war.
(*b*). Inventions.
(*c*). Design (excluding works of defence).
(*d*). Labour organization on work.
(*e*). Scientific investigations generally.
(*f*). Accounts of exploration work and surveys.

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EXPERIMENTS IN GRENADE BALLISTICS.

By MAJOR C. H. LEY, O.B.E., LATE R.E.

THE advent of the discharger-cup as a means for firing grenades from the rifle rendered advisable an investigation into interior ballistics.

The advantages the cup promised forced its adoption in advance of knowledge gained by experiment, and military requirements demanded the adaptation of the existing Mills grenade to its use, and laid down a range of 200 yards at 45° elevation as indispensable. Now with an available shot-travel of 4 inches only this meant trouble, for neither had the Service rifle been designed for any such feat nor did any means exist for determining in such a case certain elementary ballistic data such as pressures and velocities occurring in the discharger, the best size of its expansion chamber, or the intrinsic nature of stresses set up during recoil.

Rough preliminary experiments were carried out with the means available which well illustrate the nature of some of the design problems presented, the solution of which was one of the objects of the investigation to be described later.

The 2½ inch discharger, known to effect a certain kind of damage to the S.M.L.E. rifle, was utterly destructive to the one-piece stock of the 1914 pattern rifle, and neither shock-absorbers fitted to the butts, nor reasonable reduction of range by reducing the charges of propellant, were found of use as remedies.

The idea that the stresses set up between parts of the recoiling structure were, apart from external resistance, governed solely by the momentum (*i.e.* velocity) of recoil, seemed inadequate, as it took no account either of vibration, blast effect, or of the time taken in arriving at that momentum.

The time taken is a matter of acceleration or shape of the velocity curve, and with the comparatively few and light parts concerned it seemed possible that a relationship existed between this shape and the variations of the acting force or effective pressure in the discharger, which in its turn must be largely dependent upon the initial volume available for expansion of the gases behind the projectile.

Experiments to test the effect on damage to the rifle of varying the expansion-chamber in the discharger were therefore carried

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out, and incomplete and rough as they were, they did indicate much reduction of damage with larger chambers without corresponding reduction of muzzle velocities, but they of course threw no light on the part played by other phenomena. Table I. is an extract from a report on these experiments.

TABLE I.

Discharger. No.	Chamber c i.	Stroke ins.	Cartridge grains.	Mean Range. Yards.	Rounds.	Damage.
Service ... 1	3·3	4	30	200	Few	All rifles stocks split.
,, ... ,,	,,	,,	25	172	974	Do. Do. Do. (4 rifles)
,, ... ,,	,,	,,	23	160	2130	Two split out of 4.
5-inch ... 2	6·9	4·2	30	192	2020	1 out of 2, split at 800th round.
6-inch ... 3	12·8	4	30	177	3800	1 out of 4, split at 48th round.
,, ... ,,	7·8	5	30	207	30	No damage.
,, ... ,,	5·7	5·4	30	215	30	No damage.

Notes.—1914 rifles and ballistite charges used throughout. Any visible split or bending of pins counted as damage. In the case of the damaged rifle with No. 2 discharger a large number of further rounds were fired from it without further development of the small split in the stock.

In this table the muzzle velocities had not been determined. They were not essential for the preliminary object, as the range was a sufficient guide for this, but it was clear that for further progress proper instrumental means for obtaining velocity and other data of interior ballistics was essential.

Not however until the spring of last year, was opportunity afforded and apparatus found which appeared suitable for the purpose.

After some enquiries and correspondence Capt. Adams and myself were fortunate enough to be able to visit Prof. Bull of the Institut Marey, Boulogne sur Seine, whose work in developing Sound-Ranging and in the kinematography of rapidly moving objects, such as revolver bullets, the wing-motions of flying insects, etc. is well-known. We had brought dischargers etc. with us, and by the extreme kindness of Mr. Bull, who spent most of his time during three days taking and developing the photographs, we were able to come away with some very interesting films.

MR. BULL'S APPARATUS.

The apparatus was contained in a shed in the garden of the Institut Marey, and, owing to the enormously superior intensity of the light of the electric spark over that of sunlight, and to the brevity of the interval during which the film is exposed, the photos are taken in ordinary daylight.

The general arrangement as rigged up for the grenade experiments

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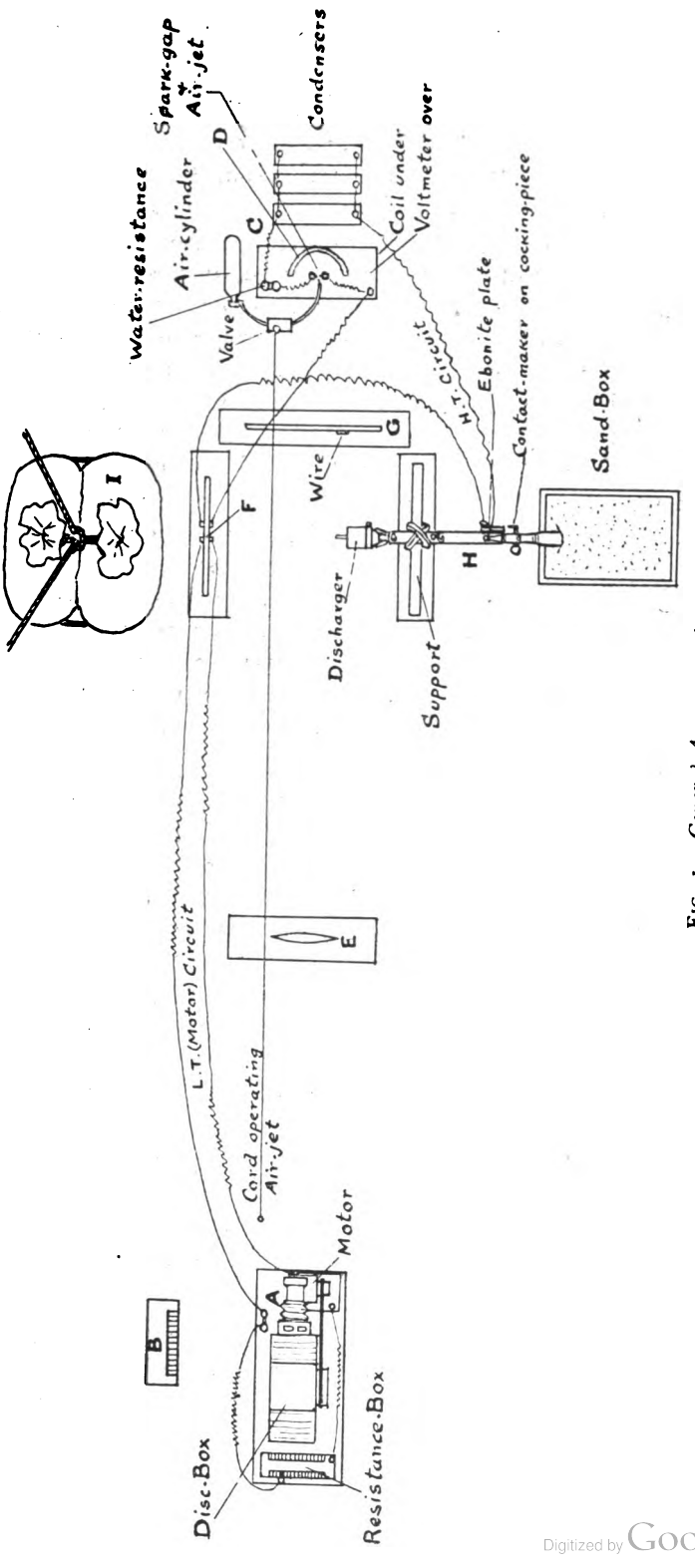

FIG. 1.—*General Arrangement.*

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is shown in the diagram, *Fig.* (1), and the parts will be referred to according to their lettering on the diagram.

(A).—A camera with electrically-controlled shutter and motor-driven disc to which the film is screwed, and a resistance box in the motor-circuit for regulating the speed.

The circumference of the disc was 108 cm.

(B).—A harmonium for ascertaining the speed. The film-disc had a 20 toothed wheel attached against which the edge of a piece of paper or film would give out a note according to the number of revolutions per second. The speed could thus be "tuned up" to any given note on the harmonium by altering the resistance. Mr. Bull informed me the error by this method was less than 2 per cent. Such an error would affect the time-scale and all the photos of one film equally, but would not affect the shape of a velocity curve.

(C).—A sparking apparatus consisting of an induction coil and condensers working up to 15,000 volts, about 20 ft. from the camera. A voltmeter, a variable water-resistance to govern the frequency of the spark, and an air-jet (supplied from a small cylinder of compressed air) under the spark-gap to prevent formation of an arc, were attached.

(D).—A parabolic mirror with 15 inch field around the spark-gap.

(E).—A 15 inch lens at a point between spark-gap and camera to suit the desired size of image.

(F).—A screen in front of the rifle carrying the stretched wires of the independent shutter and spark circuits, so placed that these circuits will be broken by passage of the projectile.

(G).—A cardboard screen, having a slot about 15 × 4¼ in. cut in it, placed across the field of light in front of the spark-gap to limit the field of the photos.

A wire was fixed across the slot to form a datum-line for measurement on each photo.

(H).—The rifle with contact-maker, supporting trestle, and sand-box for the butt, placed so that the muzzle of the discharger is opposite the slot in the cardboard screen.

(I).—Stuffed sacks suspended from the roof-truss, to receive the shots.

As regards the high-tension spark circuit one pole was connected with the contact-maker on the rifle. This consisted of a light brass arm attached to the cocking-piece, and a brass spring contact on

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an ebonite plate screwed to the fore-end, the two being adjusted so that the current passed just as the striker hit the cartridge.

The current travelled through the high-resistance wire stretched across the screen F, and so to the spark-gap, and the shadow photograph is taken in the infinitesimal time taken by the spark to jump the gap. The shutter-circuit formed part of the ordinary electric light circuit. It had been intended to connect this also through the contact-maker on the rifle, but too big a shutter delay was found, and separate hand contact was arranged for.

It was found that owing to damp only about 12,000 volts could be got out of the condensers, and the water resistance was adjusted to give a spark frequency of 3000 per second with this voltage. This adjustment is of importance to the success of the measurements, for if the frequency is too high consecutive photos will overlap at their sides and cause difficulty and confusion, if too low the photos may be too far apart for satisfactory measurement and points may be too few on the velocity curves. The speed of the projectile, the speed of the disc, and the size of the image, all enter into this consideration, and some trial shots are advisable. I understood that beyond these limiting conditions there is practically no limit to the frequency.

But the necessary first condition is that the whole time of sparking should be less than that of one revolution of the disc, and a suitable speed for the disc has therefore to be roughly calculated from what is known of the mean velocity of the projectile in the first instance.

As regards the rifle it has to be placed at an angle of elevation, and 30° was arranged for, the slot in the cardboard screen being also across the field of the mirror at the same angle. Thus the photos appear slanting across the film, This makes no difference to measurement, since all velocities have in any case to be brought to correct scale by a factor, but, with a limited travel of the stage of the microscope used in measuring the developed film, it has the drawback of causing more frequent resettings.

It was found best to strap the fore-end of the rifle loosely on the trestle so as to allow free recoil backwards while restricting the jump. Firing is safest by lanyard otherwise there is an off chance of receiving a 12,000 volt shock, a serious matter.

The general procedure was as follows :—

The electrical connections were fixed up, the camera prepared with the film and the focus adjusted, the rifle adjusted for position and loaded, and the voltage and connections of the condensers tested. The motor was then started and tuned up to speed by the harmonium, 30 revolutions per second (giving a note of 600 vibrations per sec.), being that actually used.

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The current through the coil was then started, and on the voltage rising to 11,000 the air-jet valve was opened on the word "one!" On the word "two!" the shutter was opened, and on the word "three!" the rifle was fired, these three operations taking about 2 seconds in all.

THE PHOTOGRAPHS.

Figs. 2, 3, 4 (see *Plate* facing page 136), are reproductions of films, each with a different discharger. They show the positions in shadow of the grenade and discharger with respect to the fixed wire at each spark, until the grenade has passed out of the field. The stick-like projection beyond the end of the grenade was a short grenade-rod fixed in the striker-hole to give a definite central point for measurement which would always appear beyond the discharger, and the transverse thin dark line near the muzzle is the fixed wire.

The progress of the shot can be divided into 4 distinct stages as follows;

(i). The ignition period, during which there is no motion, and which, beginning after the first spark, ends with the photo preceding the first issue of windage-gas.

The time represented by the length of this portion of film, must, if the adjustment of the contact-maker is correct, always somewhat exceed that for initial combustion up to the moment of highest pressure. It was found to be variable but appears on the average to be about ·002 second.

(ii). The relative shot-travel in the bore, or "stroke," marked by the issue of windage-gas, and terminating when the gas-check at the base of the grenade leaves the discharger cup.

It will be observed that the gas-cloud proceeds faster than the grenade and has a drift across the photos which is always upwards. The cloud has an initial velocity in the trajectory of the order 500 f.s., and an upward velocity of the order 250 f.s.

The dark object on the shoulder of the grenade is a piece of matchwood which was used to wedge up the grenade to an even seating. Its proceedings are of interest.

(iii). The "blast" period prior to the issue of smoke, marked by gas and burning ballistite beneath the gas-check.

A feature of interest here is the "pressure-ring" or block of incandescent gas with very defined and straight lower edge immediately below the gas-check on first appearance of the latter. A straight and narrow dark band, often crosses the field just below and parallel to it.

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They both disappear almost at once, showing extremely rapid outward expansion. No satisfactory explanation of the band phenomena has however so far as I know yet been furnished. The granular appearance of the gas-cloud in this stage is sometimes very marked, and may be attributed to unburnt or partially burnt flakes of ballistite.

(iv). The smoke period then begins and continues for a comparatively long time, calling for no particular comment.

It appears possible that the strong upward rush of gas past a low-velocity projectile leaving the muzzle may account for the deflection of its axis from the line of trajectory which is usually noticed. In the case of a large-headed rifle grenade with short rod the first part of the flight is with the head up and rod pointing down at a considerable angle with the trajectory, so much so that it never hits nose-first at short range.

The Method of Measurement.

It was found that the value of the results depends mainly upon the means and method of measurement, and upon the sharpness of the photos. Mr. Bull informed me that he could probably improve the sharpness of definition considerably in any future experiments. As regards the instrumental means, after many trials, I found a student's microscope, with a travelling double glass slide holding the film and operated by longitudinal and transverse rack-and-pinion attachments, with good fine scales and verniers, to be all that is practically necessary. No lantern enlargements are accurate enough.

Care is necessary that the glass slides hold the film evenly between them so that parallel motion is obtained and only slight adjustments of focus with the fine-motion focussing screw are necessary. Cross-hairs marking the centre of the field are advisable, although with practice a point on the image can be placed in the centre of the field with a fairly high degree of accuracy by estimation. A portion of the errors of measurement were undoubtedly due to absence of such cross-hairs.

The scale and vernier reading the transverse spatial distances needs to be accurate, and one was constructed for me of bone by Capt. Adams which was divided to ·02 inch, with vernier reading ·002 inch, and by rough estimation to ·0002 inch. The lines were fine and the readings were by lens. Though a considerable improvement upon the coarse millimetre scale originally fitted, further increase in accuracy could doubtless be obtained with a special scale by a good maker.

But a cause of error which seriously entered into the measurement

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of recoil was indefinition of the edges of the discharger due to the issuing gas, and some of the large variations of velocity of recoil of short period observed may be attributed to this cause. I would strongly recommend that in any future experiments a number of points be fixed to the discharger well below the muzzle which will be available for measurement. The mean of the measurements to these would be more reliable, and the use of two datum wires instead of one would greatly decrease the probable error.

The system of microscope readings employed is illustrated in *Fig.* (5), and computations were made from the means of two readings in the cases of the datum-line and discharger.

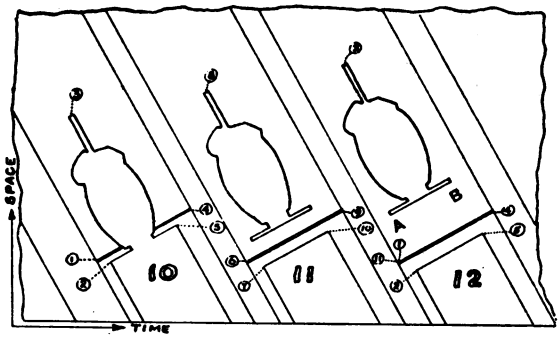

FIG. 5.—1 *Fixed Wire*, 1 *Grenade Point*, 2 *Discharger Points.*

NOTES.—Readings taken in the order shown, resetting at *Photo* 12. Readings on both scales of 1, 4, or 6, 9, and on the space-scale only of 2, 3, 5, or 7, 8, 10.

The factor for reduction of the spatial readings is determined by taking readings of points 3, A, B, *Photo* 12, and equating the resulting measure of the total length of the grenade with its actual length.

Fig. (6) shows suggested modifications, which involve two datum wires, two points on the grenade at its top end, and a sharp-edged band fixed around the discharger below the muzzle. Together with better definition, cross-hairs, better scales and verniers, and a proper buffer in lieu of a sand-box behind the butt, these should secure a great advance in accuracy, and render possible a reliable analysis in detail of the motions of both grenades and rifle.

It was found advisable to enter the readings on forms made out for the purpose, and to use special forms for the computations. The slide-rule was used for obtaining velocities.

PROGRAMME OF EXPERIMENTS.

In the brief time available in Paris it was impossible to secure a complete series of films, and although Mr. Bull has since kindly filled

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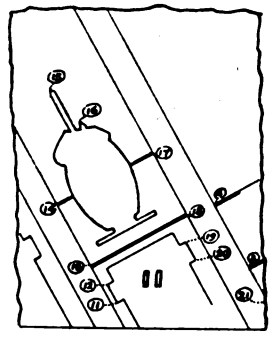

FIG. 6.—2 *Fixed Wires*, 2 *Grenade Points*, 4 *Discharger Points*.

NOTES.—Readings on each scale of 13, 14, 17, 18, and on the space-scale only of 11, 12, 15, 16, 19, 20, to be taken.

up some of the gaps, the whole programme was of a preliminary nature.

Three dischargers, selected for having even bores of approximately the same diameter, viz. 2·517 in., but having different lengths of chamber and " stroke," were used, and three shots were fired from each with Service grenades having gas-checks machined to 2·510 in. diameter. An additional group of 3 was also fired from one of these dischargers (No. III) with gas-checks machined to 2·490 in., in order to test the effect of windage.

No. I discharger was the service pattern having an expansion chamber of 3·3 cubic inches and a stroke of 4 in. (see No. 1 Table I).

No. II was the same pattern but with stops screwed in so as to increase the chamber to 7·0 c.i. and reduce the stroke to 3·2 in. It corresponded with No. 2 discharger of Table I except for a stroke shorter by 1 inch.

No. III was the discharger No. 3 of Table I, having 12·8 c.i. expansion chamber and 4 in. stroke.

In all cases the service 30-grain ballistite cartridge was used.

PLOTTING THE CURVES.

The calculated velocities were plotted for each film on squared paper against the measured time-intervals, so that 3 graphs of velocity with respect to time were obtained for each group.

Fig. (7) shows a pair of graphs from No. II discharger, selected to show the magnitude of the variations from the mean of each graph and from the smoothed mean of the three, also because of some marked oscillations referred to below. *Fig.* (8) shows recoil graphs only for Nos. I and III.

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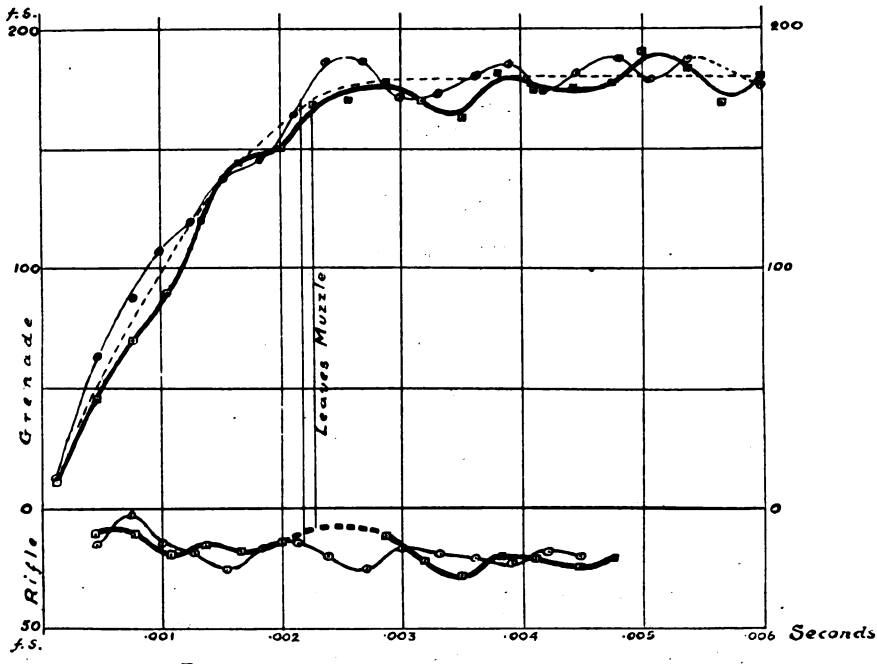

FIG. 7.—*Cup II. Velocity-Time Graphs.* (2 *Shots*).

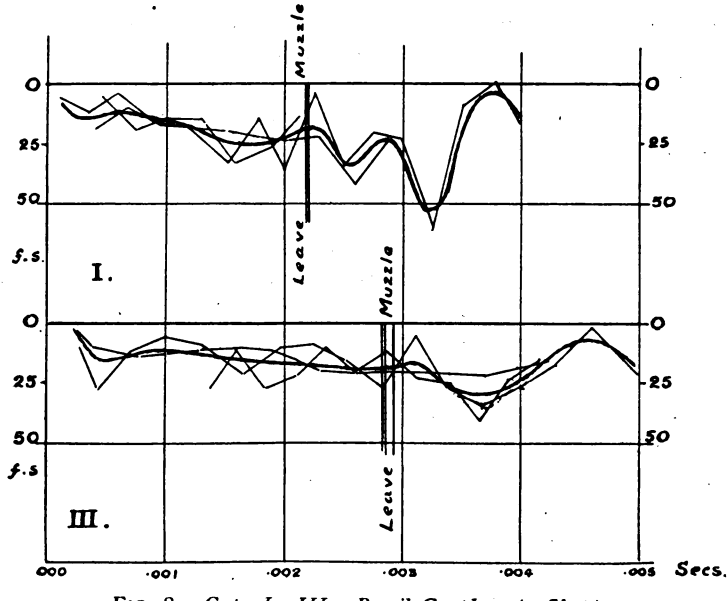

FIG. 8.—*Cups I., III. Recoil Graphs.* (3 *Shots*).

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The smoothed mean curves of each of these groups were then drawn, resulting in the 4 mean velocity-time curves of *Fig.* (9).

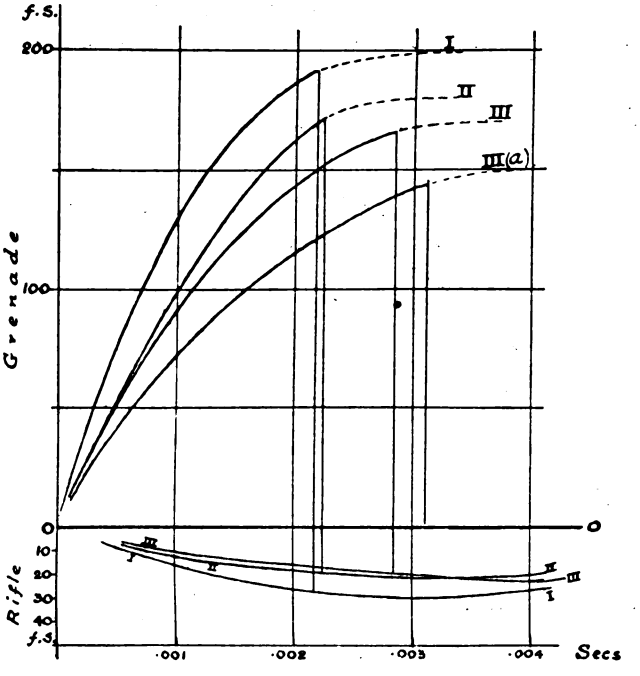

FIG. 9.—*Velocity-Time Curves* (*Smoothed Means*).

Now the acting force behind the grenade is by a law of motion proportional to the acceleration, and since this is the differential coefficient of the velocity, and is proportional to the tangent of the slope of the curve at any instant, a curve of natural tangents of the angles of slope at selected instants will represent a curve of pressures with respect to time on a scale to be determined.

To determine the scales of these curves the mean pressure of each was obtained by measuring the area enclosed up to the instant of leaving the muzzle dividing by the time up to that instant, multiplying by the space travelled through by the grenade and equating with the calculated kinetic energy at the same instant. The result gives the scale of total effective force, and dividing by the cross-section area the pressure per sq. inch is obtained.

But it is desirable to study the interior ballistics from velocity-space and pressure-space curves, and since the discharger is moving back while the grenade moves forward the sum of the spaces moved through by each at each instant were marked off on an abscissa line

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and the pressures plotted as ordinates against these. *Figs.* 10, 11 show the velocity-space and pressure-space curves derived from the time-curves in the above manner. These curves show the velocities and pressures with respect to the " expansion volumes," or " stroke," using the latter term to denote the shot-travel relative to the discharger, as distinct from the shot-travel in space.

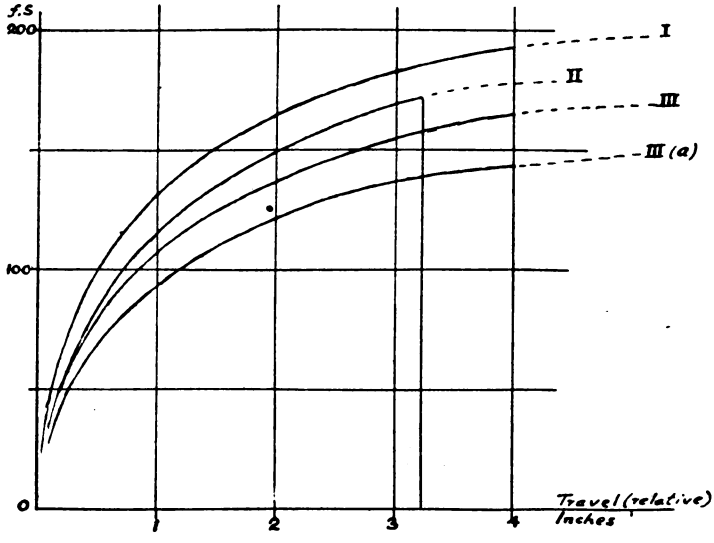

FIG. 10.—*Velocity-Space Curves (Smoothed Means).*

It should be noted that this method does not give very accurate values for the maximum pressure or pressures very near the commencement of motion, since the velocity-time curves slope steeply here, and the tangent of an angle increases very rapidly as the angle increases if the latter is large. But as the first measurements are usually very near the origin, so that the work done is small over a minute indeterminate initial period, the scale for subsequent pressures cannot be seriously affected by assuming that the velocity curve continues smoothly up to the origin itself, *i.e.* that the maximum pressure occurs at that point, prior to motion. The evidence certainly seems to warrant that procedure.

APPARENT VELOCITY OSCILLATIONS.

Oscillations of the velocity of recoil of the rifle bedded in sand would be expected, but oscillations of grenade velocity would not. All the grenade velocity graphs show oscillations on either side of the mean up to 10 per cent of the mean velocity, many of these

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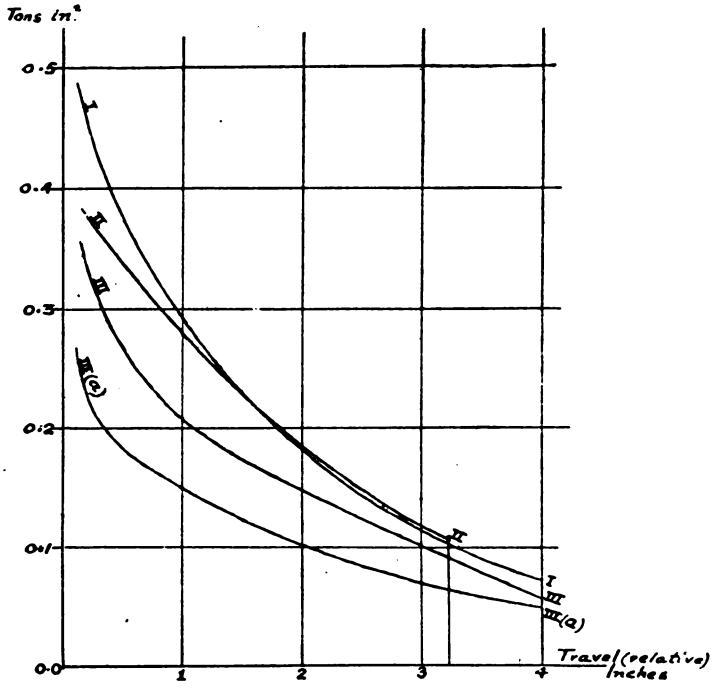

FIG. 11.—*Pressure-Space Curves (Smoothed Means).*

appear periodic, and most show the chief oscillation to take place as the grenade leaves the muzzle.

Either these are real, or due to errors of observation, or to instrumental errors; and in a given case a combination of two or more of these causes probably produces the phenomenon.

Fig. (7) shows well-marked oscillations both of the grenade and rifle, having amplitudes of about 15 f.s. and periods of about one-thousandth of a second. In the one case (thick-lined graph) the oscillations are of opposite sign, which if not real might indicate an oscillation of the datum-wire. In the other (thin-lined graph) the oscillations are of the same sign, which might indicate a large periodic error in the time-scale or in the speed of the film, or, what is equivalent, that the film is uneven or slightly ridged on the disc.

Examination shows no evidence of a scale-error nor does one of the required magnitude appear possible, and it is difficult to believe that the radius of the film on the disc or the speed of rotation can vary by such an amount. If the datum wire oscillated owing to blast it would normally appear in all the films, but only after the grenade had left the muzzle.

Periodic friction between grenade and discharger might account

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for oscillations of velocity during the stroke, as the grenade would probably wobble, and any jump of the rifle is across its trajectory, but there is little evidence of this in the photos.

That the oscillations appear as damped vibrations is very evident on the thin-lined graph of *Fig.* 7, where both the period and amplitude show regular decrease beyond the muzzle.

RECOIL OSCILLATIONS.

As regards the oscillations of the velocity of recoil, these appear much the largest during the "blast" period.

The recoil graphs of *Figs.* 7, 8, show the nature of these, and in *Fig.* 8 it appears that the mean graphs for Cups I and III are of similar nature and that III might be produced by flattening I, as by squeezing it out under a weight. While there are differences of phase in the graphs for Cup II of *Fig.* (7) the "blast oscillation" is apparent in all three Cups, and is essentially different from the normal oscillations during the "stroke" period, which might reasonably be attributed to errors.

I have endeavoured to trace connection between these large oscillations and both the "pressure-rings" appearing on the photographs, and small transverse movements or "wobble" of the discharger during recoil, but without definite result; doubtless improvements in accuracy and a more complete series of films would decide these points.

It is difficult however to avoid the surmise that the blast oscillations are in the main real, and that, if that is the case, that they are the principal sources of danger to the rifle. Their relationship to the initial chamber-volume and to the pressure curves would then form an interesting study, especially in connection with practical experiments on the lines of Table I.

SMOOTHED MEAN CURVES.

There can be little doubt however that the smoothed mean velocity and pressure curves are fairly accurate and representative.

As regards the velocity it is seen that the space-curves are nearly parabolic, and that less than 5 per cent. of the actual velocities at the muzzle is added during the subsequent blast period, though the blast of Cup II with the short stroke adds rather more than the others, as would be expected.

As regards pressure, this appears to be a maximum at, or within 0·1 inch of, the starting point. The maximum does not appear to be any simple inverse function of the chamber-volume, for approximately, the figures are as in Table II.

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TABLE II.

Cup.	Exp. Chamber.	Total Chamber.	Mean Max. Pressure.	Windage.
I.	3·3 c.i.	5·5 c.i.	0·5 tons in.	·007 in.
II.	7·0 ,,	9·2 ,,	0·4 ,, ,,	,,
III.	12·8 ,,	15 ,,	0·37 ,, ,,	,,
III.	,, ,,	,, ,,	0·28 ,, ,,	·027

Thus, with a given windage, increase of chamber effects a decrease of initial pressure in a smaller degree up to a certain point only, beyond which there is scarcely any decrease. Probably this point is in the neighbourhood of 7 c.i.

But the effect on shape of the pressure-curve is of more importance, and the advantage apparently possessed by Cup II (7 c.i. chamber) is marked, see *Fig.* (11), by a much smoother and more regularly sustained curve.

The effect of windage is important since gas-checks have hitherto been punched without machining, and rather wide limits have had to be allowed. This of course has been necessary to meet enormous and pressing demands, but it accounts for much variation of range. From the muzzle velocity curves IIIa, *Figs.* (10, 11), it appears that an increase of ·020 inch windage, obtained by decreasing the diameter of the gas-check that amount, effects decreases of about 12 per cent in muzzle velocity and 25 per cent in initial pressure.

The reduction in range would roughly speaking and for small variations be 6 per cent. per ·005 increase in windage at medium ranges, but, owing to more rapid falling off of range at higher velocities, less than this at extreme ranges.

Windage itself however, appears to affect the shape of the pressure-curve but slightly, see *Fig.* 11, with the same discharger.

Although it would be necessary for accuracy to use accurately machined gas-checks, Cups of accurate even bore are also essential for reliable results; but beyond these considerations arises the question of whether an increase in expansion-chamber or an increase in windage presents most advantage.

So far as these experiments go I believe it best to select a chamber giving the most efficient shape of pressure-curve, to use a 'stroke' which will give a sufficiently effective maximum range with minimum windage, and only to increase the latter if reduction is found essential.

FUTURE DEVELOPMENT.

I have ventured to describe the method and results of the preliminary experiments in some detail with a view to indicating particular aspects of an interesting field for future research rather than to advocate any particular theories, and I can only regret

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that circumstances prevented me from carrying the enquiry further, until more complete and reliable data had been obtained.

The apparatus required is not very expensive and if any R.E. Officers are interested in developing a branch of military science which of old belonged to them, and the token of which is still worn on the uniform of the Corps, they cannot do better than take the matter up with Professor Bull, whose extraordinary genius and readiness to help solve a thousand difficulties.

That further research in the subject is called for, and that it should be in such hands, suggests itself.

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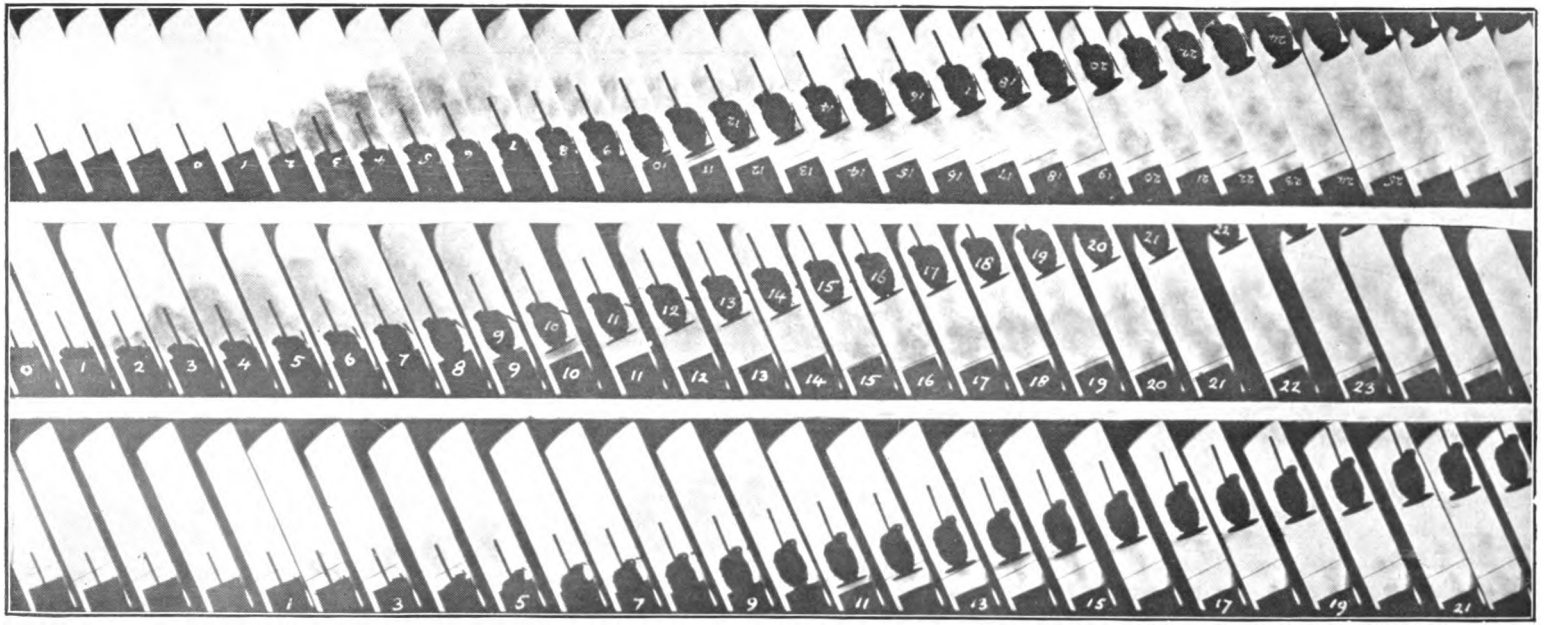

Figs. 2, 3 and 4.

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THE BATTLE OF THE SOMME.

THE 41ST DIVISIONAL ENGINEERS AT FLERS ON 15TH, 16TH AND 17TH SEPTEMBER, 1916.

From the report of the C.R.E. 41st Division.

ON the night of the 14th—15th September the Field Companies of the 41st Division were disposed as follows:—

In bivouac near Montauban, having left camp at Fricourt at 7.15, with only section transport:—

H.Q. and three sections 228th Fd. Company, R.E., under Captain E. C. Baker.

H.Q. and three sections 233rd Fd. Company, R.E., under Captain H. F. D. Thwaites.

H.Q. and three sections 237th Fd. Company, R.E., under Captain C. L. T. Matheson.

One section 228th Fd. Company under Lieut. E. T. G. Carter was detached under orders of the G.O.C. 122nd Infantry Brigade, and reported to him at York Trench at 7.0 p.m. This section taped out assembly trenches for the Brigade between the Longueval-Flers Road and the left boundary of the Divisional area, behind and parallel to the front line, in three lines, about 480 yards lay and 70 yards spacing. The section then returned to Brigade Headquarters at Green Dump. No further orders were received by this section till 8.0 a.m. on the 15th when it was told to get into touch with the O.C. front line of troops and assist in consolidating strong points round Flers. The section proceeded to a point just south of the village and constructed a strong point without infantry assistance. At about 2.0 p.m. the Brigade Major ordered Lieut. Carter to assemble all the scattered parties of infantry and take them with his Sappers round the right of Flers village, saying that he himself was taking a party round the left and would meet him on the other side. Lieut. Carter again met the B.M. at a point west of the north end of the village, and received instructions to occupy "Cox." This he did and proceeded to consolidate the position without infantry assistance. No covering party was provided. At about 5.0 p.m. word was passed down from the right to stand to. Lieut. Carter went along to the right to find the source of this order and found that the supporting infantry had retired and were going away out of sight up the valley. Being thus left in the air Lieut. Carter decided to

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withdraw his section and moved back and reported to the Brigade at York Trench, his section of 32 men having suffered 14 casualties. After remaining the night at Green Dump he received orders to return to the company bivouac.

One section of the 237th Fd. Company was detached under the orders of the G.O.C. 124th Infantry Brigade and reported to him at York Trench at 8.0 p.m. on the 14th. It was subdivided by Brigade orders into two half-sections, one half-section, under Lieut. Hunter, was ordered to report to the O.C. 26th Royal Fusiliers, the other half-section, under Sergeant Mossman, to the O.C. 32nd Royal Fusiliers, both in Edge Trench. The section then proceeded to Edge Trench, and finding no one there went on to Green Trench, where they waited till 5.0 a.m. on the 15th when the infantry arrived. The first battalion to come up was the 26th Royal Fusiliers and Lieut. Hunter accompanied them with 14 men.

Sergeant Mossman was left in Green Trench with the remaining 14 men and accompanied a party of the 15th Hants. Regt., who appeared in Green Trench, in accordance with the order of the officer with the party, as far as Switch Trench, where he reported to the O.C. 15th Hants. Regt., who told him to put two machine-gun emplacements and a fire step in the trench. This was done with infantry assistance. On reporting completion of the work to the Colonel he was ordered to return and report to his company. This he did at 1.30 p.m. on the 15th.

Lieut. Hunter in the meantime reported to the O.C. 26th Royal Fusiliers and assisted the infantry in consolidating in Switch Trench. On completion the O.C. ordered him to return, and he reported to the Brigade Headquarters in York Trench, who said that they had no further orders for him. He accordingly reported to the O.C. 237th Fd. Company at 4.0 p.m. on the 15th.

One Section 233rd Fd. Company R.E. was ordered to report at Pommiers Redoubt at 8.0 p.m. on 14th to the G.O.C. 123rd Infantry Brigade, and Lieut. Langdale, who was in command, received orders to report to the O.C. 10th Royal West Kent Regt. The section bivouacked with the R.W.K.'s till 12.30 a.m., when the party moved to York Trench, arriving there at 3.30 a.m. on 15th. No further instructions were received till 12.15 p.m., when the Battalion moved to the junction of Milk Lane and Carlton Trench, where they waited till 2.30 p.m., when the section received orders to advance between B and C Companies, and consolidate in Switch Trench. The section advanced among the various parties of the R.W.K.'s and on reaching Tea Trench, Lieut. Langdale carried out a reconnaissance with the Section Sergeant as far as Switch Trench, and sent back the Section Sergeant as a guide to the O.C. Battalion, who then brought up his Battalion and the Sappers to Switch Trench.

Here the Colonel, who had given instructions to a part of his

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Battalion to move about 800 yards to the right and was about to recall parties who had straggled further off towards High Wood, was wounded, and Lieut. Langdale assisted in binding him up and in reporting the casualty at the forward dressing station in the north-west corner of Delville Wood. He then turned up towards Switch Trench and rendezvoused his Sappers at the junction of Milk Lane and Carlton Trench, reporting to Captain Thwaites, R.E., on his arrival at about 7.0 p.m. on the 15th, who then took charge of the half-section with the other two sections that he was taking up for consolidating work in rear of Flers. In the meantime Corporal Rice with half of the section had moved with the right column of the 10th R.W.K.'s, and assisted the Infantry in the consolidation of a portion of Switch Trench on the west of the Longueval-Flers road. At about 9.0 p.m. the work in hand was completed and no officer being present Corpl. Rice returned with his Sappers to the Company Headquarters and reported himself.

The remainder of the R.E. acted under Divisional orders, conveyed through the C.R.E., on the night of the 15th—16th. Captain Baker was ordered to proceed with the remaining three sections of his company, two sections of the 237th and one section of the 233rd, to consolidate the Box-Cox-Hogshead line in front of Flers.

In front of Longueval Captain Baker and Lieut. Berry were severely wounded and Captain Matheson took command of the six sections.

Information being received that no line in front of Flers was held, Captain Matheson reconnoitred to ascertain where the front line was. Finding that the Infantry had fallen back from Hogshead and that a front line was being held on the right of Flers, he consolidated this line, making strong points on each flank and one central one, with also a machine-gun emplacement on the right return flank. The work being completed at about 1.0 p.m., one section of 237th Fd. Company and one section of 233rd Fd. Company were left to consolidate the Brown line in accordance with instructions.

Two sections 233rd Fd. Company under command of Captain Thwaites were employed at the same time consolidating behind the line of Flers Trench, behind the village, in continuation of the work carried out by Lieut. Carter in the day-time, using the old wire of Flers Trench as an obstacle.

On the 16th the two sections who had not yet been employed worked on the improvements of the Montauban Quarry road, which was being used for evacuation of the wounded from the advanced Dressing Station.

On the night of 16th—17th, four sections under command of Captain Thwaites were ordered to proceed to Flers to report to the Commandant of Flers, and consolidate the line Box-Cox-Hogshead. Finding Box occupied by troops of the New Zealand Division, work was concentrated on Cox and Hogshead, and on completing the

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gaps in a connecting trench which the infantry had dug, also in making a short length of C.T. back to the sunken road. The two sections at work in the Brown line were ordered to be relieved, and one additional section was sent to the Green line to work till 4.0 a.m. On the 17th these sections were again employed on the Montauban Quarry road.

On the afternoon of the 17th all the Companies of the Division were withdrawn to Fricourt.

The lessons learnt as regards R.E. work were :—

1. That R.E. should as far as possible be employed under the direct orders of the Division on definite work of tactical value. The sections given to the Brigades were left almost entirely on their own initiative without definite instructions.

2. No party of R.E. of less size than a section under an officer should be employed, except perhaps a few guides who would be very useful to show the Infantry the way, and avoid the confusion which occurred through lack of knowledge of the trenches and of the direction of the attack. These should rejoin their sections at once.

3. A preliminary engineer reconnaissance of the positions to be consolidated, before the night parties of R.E. are sent out, would be very helpful in deciding what numbers of men, tools and materials are likely to be required.

4. One stretcher per R.E. section should be carried, the regimental stretcher bearer system is very apt to leave out the R.E. who have no stretcher bearers of their own. If two stretcher bearers per section could be added supernumerary to the strength they would be very useful in other ways.

5. For tool transport the pack cobs were found very useful, the conditions were impossible for getting tool-carts forward. It is suggested that a second pack saddle per section should be carried for use on a spare horse or cob. This would enable one pick and shovel for each man to be carried so that the Sappers could each carry up 25 sand bags for consolidation work.

In only one case was an infantry carrying party provided and so the Sappers had to rely on what they could bring or find for themselves.

6. Generally the Infantry did not yet appear to appreciate the tactical value of the Sappers ; and except where they were employed directly under Division orders, with a Company Commander in charge, their work was apt to be misdirected. Probably therefore in working with the New Army, especially as the Officers themselves were lacking in experience, it would be advisable to work the Field Companies as far as possible as complete units.

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THE WORKS DIRECTORATE, MESOPOTAMIA EXPEDITIONARY FORCE.

PART II.—BAGHDAD AND FORWARD AREA.

On the capture of Baghdad on 11th March 1917 it was decided to form a separate Works Organisation working directly under G.H.Q. to carry out works north of the Diala River, with Colonel H. L. Pearson R.E. as Deputy Director.

Although the Turks had done a large amount of damage to buildings and machinery in Baghdad, there were several large well-built buildings remaining which were taken over for conversion into hospitals. Of these, the Jews' Hospital was used as an isolation hospital, the Turkish Military Hospital as a British, and the Turkish Military School as an Indian Hospital. These buildings required little alteration beyond petty repairs and the addition of sanitary annexes and cook houses.

The Turkish Infantry Barracks taken over as a British Hospital and the Cavalry Barracks as an Indian Hospital, although not seriously damaged, were found to be in such an indescribably filthy condition that they had to be thoroughly disinfected and cleaned before they could be brought into use, and the usual offices had also to be added to these buildings.

In addition, three houses belonging to Kasim Pasha, on the right bank of the Tigris, were converted into an Officers' hospital, and a row of private houses, known as Fenareh Houses, on the left bank about two miles below Baghdad, were made into the Officers' Convalescent Depot. Both of these groups required considerable alterations and repairs before they could be made suitable for these purposes.

In order to increase the hospital accommodation it was decided to construct a hutted Indian hospital of 1000 beds near the Cavalry Barracks, north of the city.

Before the fall of Baghdad the British Consulate had been used as a Turkish hospital, but on the arrival of the British the patients were moved to the old Turkish Military Hospital and the building was taken over as G.H.Q., the *personnel* of Headquarters with the Directors and their staffs being billeted in houses near the consulate.

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Considerable work was necessary to adapt the houses to make them suitable for offices and quarters.

The G.O.C. Baghdad garrison and his staff were billeted near the north gate of the city, and the garrison lay under canvas to the north of the city and in the German barracks in the citadel.

The citadel was put to its former use as an ammunition dump and Ordnance depot, as, in spite of numerous fires and explosions, the majority of the buildings, except the workshop and main bakery, were undamaged. The bakery and workshop had been demolished and it was necessary to rebuild them, but many machines were salved from the debris of the workshop and were put to useful employment by the A.O.D.

A second bakery in Hospital Street had also suffered considerable damage, but was repaired in the early days of the British occupation.

Other important buildings damaged by the Turks before evacuation were :—

1. The flour mill, north of Baghdad, completely destroyed and machinery blown up, the chimney alone remaining ;
2. The German Wireless Station, masts blown down, machinery destroyed and buildings damaged ;
3. The Turkish Government Clothing Factory, all machinery destroyed and buildings damaged ;
4. The Turkish Magazine at the East gate, blown up ; and
5. Messrs. Lynch Bros. premises, building damaged.

Many of the charges in these and other buildings had failed to explode, and in some cases the fuses had not even been lighted, due no doubt to the hurried exit of the Turk.

During the night of the 10th—11th March the Kurds in Baghdad started looting the bazaar, but the damage they did was of no military importance.

With the advance of the troops beyond Baghdad, an Advanced Base was established about five miles below the city. The headquarters were accommodated in two buildings on the left bank of the Tigris at Karradah, and other buildings on the river front were taken over as offices and billets. The main depots and the rest-camp were on the right bank.

Four casualty clearing stations were also installed at the Advanced Base, and convalescent depots, each for 1000 beds, were sited on each bank of the river.

During the hot weather of 1917 it was decided that all units at Advanced Base should remain under canvas, but in spite of this a large amount of work had to be carried out in this area, building incinerators, latrines and cook houses, laying out and maintaining roads, providing dug-outs for shelter from the heat, etc.

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After the capture of Baghdad there were three lines of advance, the easternmost up the Diala, the centre one up the Tigris and the western up the Euphrates. The existing Baghdad-Samarrah Railway ran on the right bank of the Tigris, but it was decided that the Baghdad-Kut line should be on the left bank. It therefore became necessary to form new dumps on the left bank, and the Hinaidi peninsula was selected as the advanced base for troops and supplies intended for formations on the left bank. Work was carried out at Hinaidi similar to that at the other Advanced Base.

The city of Baghdad contained few streets capable of taking wheeled traffic, most of the so-called streets being narrow passage-ways between the houses, twisting and turning in all directions. During the war however the Turks had cut a main street, which they had called Khalil Pasha Street, through the city from the north to the south gate. The demolition of the houses for the construction of this street had been carried out only a short time before the British captured the city, and as soon as labour became available the completion of the work was undertaken, holes being filled up and the surface levelled. The street was renamed New Street.

Further demolition of buildings was carried out on both banks of the river, for the construction of roads leading to bridges over the river.

In addition to the roads within the areas of Baghdad city, Advanced Base and Hinaidi, trunk roads were built connecting the city with the two latter. In each case the system, which had been successful in the Field Army before Sunnaiyat, of building two roads, one of which was reserved for motor traffic, was followed.

Before the British occupation most of the houses in the city were provided with a piped water supply, and the installations were not damaged by the Turks. These consisted of oil engines driving centrifugal pumps which lifted the water from the river into troughs about ten feet above the ground, from whence it ran by gravity through the pipe lines. The pipes were cast-iron spigot and socket pipes, the joints having been mostly made with mud. The tracing of the pipe lines, of which no plans existed, was a work of some difficulty. It was also frequently necessary to clean out pipes which had become blocked with silt, and it was not uncommon to find lengths of small diameter in a line which was understood to be of larger diameter throughout. Considerable improvements and additions were carried out to the water supply, and among other works stand-pipes were placed on all the roads for street-watering gangs.

The water supply at Advanced Base was provided by pumping from the river by an Arab-owned engine and pump, the water being distributed through the camps and depots in open channels, running

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along the roads. This water was at first used both for drinking and road-watering, but in June the two supplies were divided and three miles of piping were laid to distribute the drinking water.

Electrical supply was practically unknown in Baghdad before the British occupation, there being only two Cinematograph sets and a supply at the Turkish Military Hospital, but it was understood that a scheme for supply of electrical power and the provision of a tram service were under consideration by a British company before the outbreak of war. The installation in the Turkish Military Hospital was a small set, sufficient to supply one light in each ward and one on each verandah, and this did good service until more powerful plant could be installed.

On the occupation it was decided that electric light and fans should be provided for G.H.Q., and all hospitals in Baghdad city, while the tented casualty clearing stations and convalescent depots at Advanced Base should be provided with punkahs if necessary. Owing to the limited time available before the advent of the hot weather, it was not possible to erect any heavy plant in time to provide power for the fans, and it was therefore decided to erect five local power stations to deal with the loads in their immediate vicinity. The question of concentrating the supply of power was not lost sight of, and proposals were put forward for the erection of a Central Power Station with plant which was already available at Busra. In May 1917 a scheme was put forward and received approval. The site selected for the Power Station was in the Turkish Military Clothing Factory, the buildings of which had escaped without serious damage, and provided accommodation for a small workshop and quarters for the British *personnel* of the E and M Section.

The provision of the temporary plants for the hot weather of 1917 did not make the progress hoped for owing to shipping delays, but by the end of July both British hospitals, the Officers' hospital and convalescent home, and G.H.Q. were receiving a limited supply of electric power during the hot hours of the day and during the evenings. Owing to shortage of plant the supply was not as reliable as could have been wished.

Baghdad contained several locally-owned ice-plants which it was estimated would provide enough ice during the hot weather of 1917 for the needs of the force. It was therefore decided not to erect any government plant that year, but to rely on the local plants, assisting the owners by providing stores to keep them going, and regularly inspecting their plants. Two barges fitted with ice-plants were sent up from Busra, one of which was sent to Chaldari to supply the troops in camp there, and the other was moored at Karradah to meet the requirements in that area. At Baqubah a municipal-owned ice-plant was found, and arrangements were made for this

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to be worked for the benefit of the troops stationed there. Towards the end of June the erection of a one-ton ice-plant was begun at Advanced Base, but it was not ready in time to do useful work during the hot weather of 1917.

The Engineer Field Park was originally established at Advanced Base, the materials in stock at Sheikh Saad being transferred there, but on the inauguration of the Works Directorate at Baghdad a second Park was established in that city, the site selected for it being the old Turkish Customs House, which had a small wharf with two hand-operated cranes, and yards and houses with cellars affording ample storage accommodation. Large consignments of stores soon began to arrive and in the meanwhile the officer in charge was fully occupied in searching for and buying up the engineering materials which were to be found in the bazaar. The Baghdad Park took over as wood-working shops the Turkish aeroplane repair shops, which contained power-operated wood-working machines, the property of a Baghdad merchant, and a considerable amount of useful work was done there. It was soon decided that, as the system of having two Parks was unsatisfactory, the Advanced Base Park should become the Expeditionary Field Park and Baghdad City Park should be a works dump issuing stores to works units only.

In July 1917 the Army Commander decided that the Baghdad Works Directorate should cease to be a separate organization, and the Director of Works, Brigadier General Stokes-Roberts, took it over in addition to the L. of C. Works Directorate. Shortly after this the work was organised with two Assistant Directors, one at Advanced Base and the other in Baghdad, but this division of the work was not found to be satisfactory, owing to the difficulties of river transport, and at the end of 1917 their responsibilities were changed to the charge of the Right Bank and Left Bank of the Tigris, respectively.

With the extension of the Lines of Communication the road work of the Directorate was largely increased, and in spite of many difficulties, mostly connected with transport, all roads were greatly improved. A new hutted hospital, No 65 B.G.H., for 1000 beds, was also completed at Karradah in these early days of the occupation.

In the spring of 1918 the Works Directorate had large responsibilities in the building and upkeep of the bunds which had to be erected round Baghdad and Hinaidi to protect the city and camping areas from floods on the rise of the river. The area was successfully protected, but some anxiety was caused by the river washing away its banks in the neighbourhood of Hinaidi and exposing the foundations of several houses employed as billets. The billets had to be evacuated, but the houses stood and the bank was repaired as the

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river fell. In July 1918 the bunds were handed over to the Irrigation Directorate.

Considerable improvements to the water-supply in and around Baghdad were carried out during this year. Three water filtration plants were erected, one to supply the camps at Hinaidi, another the hospital area to the north of the city and the third the Advanced Base on the right bank The erection was commenced in February 1918 and the second started to pump filtered water in July.

An improvement in the supply to Baghdad city was also designed and carried out. A pumping station with settling tanks was erected to the north of the city, but owing to difficulties in connection with the tanks it was not possible to provide the city with settled water before the close of the year. It was at first intended to provide the whole city on both banks with water from this pumping station, the right bank being served by a pipe line to be taken across the river on a railway bridge which it was proposed to erect. But during the hot weather of 1918 it was found that the consumption of water by the civil population had risen so largely, owing to the improvements in the supply, that all calculations were falsified, and the new pumping station, far from supplying the whole city, could only provide for a portion of it on the left bank, and that the old Turkish pumping stations were still required. Additional overhead steel-plate storage tanks were also erected in Baghdad to improve the supply.

A large refugee camp was ordered to be prepared at Baqubah in August 1918, and finally provided accommodation for about 50,000 refugees who had come down from North-west Persia to put themselves under British protection. The Works Directorate provided many camp structures and a water-supply and roads throughout the camp.

During the cold weather of 1917-18 a Central Power Station was erected in Baghdad. Power mains were run through the streets and the local electrical installations were dismantled. High-tension lines were run to the hospital area north of the city and to Karradah and Hinaidi, the electrical loads at these places being connected to the main supply. The station itself consisted of four Babcocks and Wilcox boilers, complete with apparatus for oil-fuel firing, two D.C. 250 Kilowatt sets, one 200 K.W. and one small A.C. set, a rotary converter and the usual switchgear, balances, etc.

It was decided not to connect Advanced Base to the supply, and the Station there was enlarged to take the additional load in that area.

The right bank portion of the city was to have been connected to the Central Power Station, but, owing to the delay in the arrival of the cable, it was not possible to do this before October 1918. A

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temporary cable across the river was tried, but the experiment was not a success, and the local plants at the Officers' hospital continued working throughout the hot weather of 1918, additional plant being also installed at I Corps Headquarters and at the Railway Station and yards.

Electrical plants and filtration water-supplies were also installed at Hilla and Ramadie, and small electrical installations were provided for Divisional Headquarters during the hot weather of 1918.

For the ice-supply during 1918 it was decided to erect a main Government Ice Factory at the old Turkish Clothing Factory, and to become independent of the somewhat expensive method of purchasing from local factories. A ten ton, a six ton and a four ton plant were erected, and a reserve supply of 150 tons of ice was collected in an ice-store which was also built at the Clothing Factory. As a main supply for the right bank a private ice-factory with an out-turn of about ten tons a day was hired, completely overhauled and improved, and worked by government during the hot weather.

For the first time it was possible, during the hot weather of 1918, to make provision for the supply of ice to the Field Army, and ice-plants were erected at Abu Saida, Qizil Robat and Kifri, to the north-east of Baghdad, Samarra on the Tigris, and as far north as Ramadie and Hit on the Euphrates. 1800 tons of ice were turned out from these plants during this hot weather.

In the spring of 1918 it was decided that the E and M Section of the Directorate should do all mechanical work required for the agricultural development of the country, and all engines and pumps, flour-mills, etc., the property of Arabs, were inspected and put in order. The repairing of many of these placed a heavy burden on the workshop staff, and the workshops had to be considerably enlarged and additional tools and machines ordered to keep pace with the work.

With the extension of the railways north of Baghdad and opening up of the country a certain amount of building material could be brought in from the north, bitumen and lime being obtainable from Hit, gravel from Feluja, and gravel and lime-stone from Table Mountain. With the gravel thus obtained it was possible to metal a considerable portion of New Street.

Among other works carried out towards the end of the war there may be mentioned the rebuilding of the retaining walls along the river bank in Baghdad City, and the erection of a cold-store at Advanced Base with a manufacturing capacity of 3 tons of ice and storage for 60 tons of frozen meat from the local stocks. The water-supply of Nejef was placed in order after that city had surrendered to the British, and a start was made on the erection of a large flour-

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mill which had been despatched by the War Office to deal with the local harvest.

On the signing of the armistice preparations were made for the erection of a large military cantonment outside Baghdad city.

[NOTE.—An excellent map of Lower Mesopotamia between Baghdad and the Persian Gulf, with railways revised to November, 1919, is supplied with Sir John Hewett's Report to the Army Council on Mesopotamia, published by H.M. Stationery Office at the price of 1s. 6d.—EDITOR, *R.E.J.*]

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THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914—1919.

CHAPTER V.

BRIDGING.

MISCELLANEOUS.

1.—DISMANTLING STEEL BRIDGES.

Soon after the Armistice instructions were issued from G.H.Q. for a number of steel bridges in the neighbourhood of Amiens and St. Omer to be dismantled, and returned to the base.

This work was organised by the Chief Engineer of the VII. Corps, and was carried out by the 227th Field Company in the Amiens area, and the 556th Army Troops Company in the St. Omer area.

Instructions were issued by the E. in C. as follows :—

"(*a*) Bridges taken down will have all parts clearly marked and packed in accordance with the Tables given in 'Portable Road Bridges' (I.I.S. War Office, March 1916, and additions issued from time to time).

(*b*) Bolts and nuts are short, and great care must be taken that they are undamaged, greased and packed in boxes, which will be carefully packed.

(*c*) Each Bridge will be packed complete with decking, etc., and a notification of any deficiencies will be sent to the Engineer in Chief's Office, in order that they may be replaced from the Base.

(*d*) *Disposal of Bridges.*—A notification will be sent to E. in C.'s office at least three days before the Bridge is ready for despatch, when a destination for the Bridge will be given, and truckage arranged for.

The Bridge will be put on rail and will be conveyed to its destination by a suitable escort.

Duplicate way-bills will be made out and a copy signed by the Officer in Charge at the Receiving Dump or Store will be forwarded to the E. in C.

(*e*) Slab approaches will be taken up and delivered at nearest Railhead, and loaded on trucks.

Notification will be sent to E. in C's Office of the number of trucks of slabs which will be delivered at each Railhead, and the date when they will be ready for loading.

E. in C. will arrange truckage and give destination."

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Nineteen Bridges of various types were dismantled in the Amiens area, and eight in the St. Omer area. A large number of slabs and sleepers were also lifted and despatched from the approach roads. Labour was supplied by companies of prisoners of war, and was very satisfactory. No difficulties were found in the technical work of dismantling spans.

Generally speaking the lessons learnt were similar to those in the erection of steel bridges, that is to say that the most important work was that connected with the transport and packing of material.

The special plant and tools that were found necessary for the use of one Field Company employed on this work were as follows :—

Designation.	*Unit.*	*Quantity.*
Bag, Sand	No.	500
Bars, Pinching	No.	24
Brushes, Paint	No.	6
Cordage, 3 in. (130 fathoms per coil)	Coils.	2
Cranes, Loading, 1 ton	No.	2
Crow-bars 5ft. 6 in.	No.	24
Cutters, Wire	No.	6
Derricks, Lattice, (with 2 sets of blocks for each, 1 treble, 1 double, and 1 snatch)	No.	2
Grease (28 lb drums)	Drums.	2
Hammers, (5 lb.)	No.	24
,, (2½ lb.)	No.	48
,, Sledge (9 lb.)	No.	12
Handles, Hammer, assorted ...	No.	6
Heads, Pick	No.	12
Helves, Pick	No.	12
Jacks, Derrick (5 ton)	No.	4
Jacks, Derrick (6 ton)	No.	10
Oil, lubricating, Mineral	Drums.	2
Paint, Black	Drums.	1
,, White	Drums.	1
Rollers, launching, special ...	No.	8
Shovels, R.E.	No.	12
Spanners, ½ in.	No.	24
,, ⅝ in.	No.	24
,, ¾ in.	No.	24
,, Box	No.	2
Wire, plain, No. 14 gauge	Coils.	6
Wire Rope, 2 in.	Coils.	2
Winches, 2 ton	No.	4

The above stores were additional to the ordinary tools in possession of a Field Company, or obtainable from an Advanced R.E. Park.

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Transport from bridge sites to rail in the Amiens district had to be chiefly done by 3-ton lorries, which caused a good deal of delay and difficulty in loading long girders and timbers.

In the St. Omer district, all material was loaded direct on to barge, and taken to the base by canal.

2.—Clearing and Regulating Operations on Canals.

During their retreat the Germans not only destroyed most of the road and railway bridges, but also succeeded in making considerable water obstacles by damming sections of the French and Belgian canals and cutting gaps through the banks up stream of the dams. They also carried out a large amount of wanton destruction of locks on the main canals.

The actual responsibility for clearing and repairing navigable canals lay with the Inland Water Transport, who were, however, quite unable to keep pace with the rate of advance, and the amount of destruction. The preliminary work of clearing waterways for flood water, and reduction of water level in the inundated areas, thus fell to the Chief Engineers of British Armies. The canal system of France and Belgium is a very complex one, and control of all water removal schemes had necessarily to be centralized. All possible information had been collected in the Office of the E. in C., and instructions were issued to all the Armies concerned as to the best means, and channels through which to let out flood water.

The biggest inundations and most extensive damage were on the Scarpe and the Escaut, and the clearance of these waterways, and surrounding areas, was entrusted shortly after the Armistice to the Chief Engineer of the VII. Corps, and was by him divided into a Northern and Southern Sector, each under a Lieutenant-Colonel R.E.

Description of Locks.—The locks on these canals are from 38·50 metres to 38·70 metres in length, and from 5·10 metres to 5·20 metres in width, with 2 metres draught. In the masonry walls up stream, lock gates, slots or chases approximately 20 to 25 cm. square in cross section existed to take wooden stop-logs, or *poutrelles*, by which the waterway could be completely closed.

Similar arrangements are also provided on the bye-pass channels.

Description of Blocks or Dams made by the Germans.—The methods of blocking adopted by the Germans were :—

(*a*) Dams made of fascines and earth on the down stream side of a row of rough piling, and built up to the level of the canal banks.

(*b*) Block formed by filling in at a lock with bricks, fascines, mud and rubbish, between the *poutrelles* and the lock gates.

In some cases barges partially filled with bricks were also sunk in the locks.

The work of clearing some of these locks was made most unpleasant by the putrifying remains of dead horses which had apparently been

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cut up by the Germans, and mixed in with the débris between the *poutrelles* and the lock gates. Cut up dead horses were also found in the small bye-passes by which the locks are normally emptied.

Demolitions by Germans.—In some cases both ends of a lock were thus blocked. In other cases the up stream end only was blocked, the down stream end being entirely demolished.

The explosives used by the Germans were generally groups of large calibre H.E. shells, four on each side of the lock sunk about 2 metres deep, and 1 to 2 metres behind the brick backing of the masonry walls of the locks. The resultant craters were approximately 4 metres deep, and 8 to 9 metres diameter.

The work had evidently been very carefully planned to do the maximum damage to the canals consistent with retaining a head of water at those places where inundations were intended; for example, locks 8 at Denain, and 9 at Haulchin were completely demolished, craters being formed on either side of both up and down stream gates, whereas lock 10 at Trith St. Leger was blocked at both ends, and a steel barge sunk in it.

Clearing the Locks.—Where the locks were totally destroyed, all that could be done was to take out the larger débris, and so allow a free passage for storm water.

Where locks were dammed and contained sunk barges, an efficient water-lock was made by sinking a tarpaulin on the up stream of the *poutrelles*, so closing off the water.

Débris between *poutrelles* and lock gates was then removed: dead horses piled on the banks and burnt, and barges cut into sections by the use of explosives, and then pulled out by means of a caterpillar tractor.

Other Obstructions.—Through Valenciennes there are three main water channels:—

(*a*) Canal de l'Escaut (The navigable Canal).
(*b*) Canal de Charge } To take all water except
(*c*) Old bed of the Escaut River } lock water.

A side channel controlled by *poutrelles* connects (*a*) and (*b*).

This channel is some 300 yards long, and had been blocked, as well as part of the Canal de Charge, by felling some 20 large trees, and dropping them into the channel. A steel barge was also sunk into the channel.

Work of clearing was first started by cutting the trees up into sections by the use of German stick grenades. A 2 ft. 6 in. diameter tree could be broken in half by four of these grenades lashed round it, and fired simultaneously. The tree sections were then hauled out by winches found in the neighbouring mills or workshops. After a few days a caterpillar tractor was obtained by means of which whole trees 40 ft. to 50 ft. long easily pulled out.

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Dams.—Dams were cleared by explosives, usually groups of 5·9 German shell in twos and threes, with one gun cotton primer fired electrically, the shells being dug down 4 to 5 feet into the dams, thus clearing a waterway, and as the water fell, smaller charges were used to cut down stumps of piles still remaining.

Demolished Bridges.—Practically every bridge across these canals had been totally or seriously damaged. These included Pont Levis, Pont Tournant, steel lattice and plate girders, masonry arches, and reinforced concrete arch bridges (road and railway).

The débris from these demolitions caused formidable obstructions, which generally had to be removed by the continual use of small charges of explosives.

At Antoing divers had to be employed for five or six weeks to remove débris of masonry, steel-work, etc., also at several locks to examine and assist in removing damaged lock gates where it was not possible to release the lock water.

Regulation and Control of Water in Canals.—The comparatively dry weather in November and beginning of December assisted the clearing operations greatly.

All the worst obstructions were removed, and the levels of the various reaches of the Escaut and Scarpe canals reduced to below normal before the heavy rains began. This enabled the inundated portions of the country in the Escaut valley to be drained.

At all locks and bye-passes not totally destroyed steps were taken to recover control of the water in the reaches, either by means of stop-logs or undamaged gates, so that the level of reaches could be raised or lowered. This largely helped to protect the canal banks.

In all this work the greatest care was taken to do nothing which should interfere with the future work of permanent re-construction.

Units employed.—The following R.E. Units were employed :—

411th and 550th Field Companies.
172, 175, 176, 251 and 253 Tunnelling Companies,
196 Land Drainage Company,
Detachment of 8th Canadian Engineer Battalion,
Detachment of 3rd Australian Tunnelling Company, and
Detachment of I.W.T. (Divers, etc.).

[Previous articles under the heading of "The Work of the Royal Engineers during the European War, 1914—19" appeared in the *R.E. Journals* of September, 1919 (Introduction p. 105; Anti-Aircraft Searchlights, France, p. 106; Postal Section—Army Postal Services, p. 114), October (Bridging, Chapter I., p. 162), November (Bridging, Chapter II., p. 200), December (Bridging, Chapter III., p. 261), January 1920 (Bridging, Chapter III., (*continued*), p. 13), and February (Bridging, Chapter IV., p. 61; Organization of Engineer Intelligence and Information, p. 79). Copies of these Journals may be obtained through the usual channels.]

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MEMOIR.

COLONEL SIR HENRY EDWARD McCALLUM, G.C.M.G.

THE death of Sir Henry McCallum, which occurred at Camberley after a long illness on November 24th, 1919, removes a distinguished Royal Engineer Officer and a servant of the Crown who, in a civil capacity, held high office in various dependencies of the Empire.

The eldest son of Major H. A. McCallum, R.M.L.I., Sir Henry was born in 1852. Entering the Royal Military Academy at the age of 16, he passed out in 1871, first among a batch of 52 cadets with the Pollock Medal, and in due course received a Commission in the Royal Engineers. After two years spent in practical training at the School of Military Engineering, Chatham, where his ability in constructional work gained him the Fowke Medal, he was appointed in 1874 Superintendent of Telegraphs for the Southern District. A few months later he was transferred to the Office of the Inspector-General of Fortifications, remaining there until the following year when his long association with the East began.

In 1875, Sir Henry, who was then 23 years of age, accompanied Sir William Jervois, the Governor of the Straits Settlements and himself a Royal Engineer Officer, to Singapore as Private Secretary, thus making his first acquaintance with Crown Colony Government. To a young man, capable, industrious and energetic, the opportunity so afforded of familiarizing himself with the methods of Colonial administration and the association with problems attending the government of native races, furnished an invaluable training. Of this training Sir Henry took the fullest advantage, and the insight into affairs gained in these early days, the knowledge acquired and the lessons learned, coupled with the industry and high sense of duty which distinguished him throughout his life, fostered his natural talents and laid the foundation of the political wisdom which in later life was employed to so great advantage in the service of the Crown. During his two years of service as Private Secretary Sir Henry accompanied the Governor on various missions to the native states of the Malay Peninsula. He took part in the Perak war of 1876, receiving the medal and clasp, and was several times mentioned in despatches for services both in the campaign and in connection with the Commission of Enquiry which followed. In 1877 he

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Col. Sir Henry Edward McCallum, G.C.M.G.

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returned to his Corps, and after spending a short time at Hong Kong as Superintending Engineer of the Admiralty Works he returned in the following year to Singapore, where he had been chosen to devise measures for the defence of the port. Thereafter, he was attached to the Office of the Inspector of Works at the Royal Arsenal, Woolwich, until in 1880 he took service under the Government of the Straits Settlements as Deputy Colonial Engineer.

For the next seventeen years his lot was cast with the Colony. In 1884 he was appointed Colonial Engineer and Surveyor-General, and from this time onward until he left the Straits Settlements thirteen years later, he was intimately associated in a number of important capacities with the administrative and social life of the Colony. A member of both the Legislative and Executive Councils, he was also for a time Commandant of the Singapore Volunteer Artillery. For some years he was President of the Singapore Municipality and in this capacity his frank and kindly nature did much to encourage and preserve the good relations existing between all sections of the community. But although in the service of the Colonial Office, he retained his connection with his Corps. He was promoted to Captain in 1883; in 1890 he became a Major on the reserve list, and he was made a Lieut-Colonel in 1897. Three years later he was promoted to Colonel, and it was not until 1909 that he was placed on the retired list. In 1885 when, following the Panjdeh affair, Great Britain appeared to be within measurable distance of war with Russia, Sir Henry's professional knowledge was again requisitioned by the War Office who entrusted to him the important task of constructing new fortifications at Singapore. This duty he performed with great skill and thoroughness and on the completion of the work his services were acknowledged by the award of a C.M.G. A few years later, in 1891, when native disturbances broke out at Pahang in the Malay Peninsula, the Straits Settlements Government appointed him Special Commissioner for the disaffected area. Here he displayed ability and firmness in dealing with the situation and his success in suppressing the outbreak earned him the thanks of His Majesty's Government.

It was not to be expected that an officer of Sir Henry's administrative capacity would remain indefinitely in a subordinate position. His exceptional gifts of mind and character singled him out for promotion, and his opportunity came in 1897 when he was appointed to the vacant Governorship of Lagos. In directing the destinies of a young and undeveloped Colony Sir Henry found many matters to tax his strength and test his judgment, and in the execution of his task the apprenticeship which he had already served stood him in good stead. But beyond the normal administrative duties of a Governor, there existed in British West Africa at that time exceptional circumstances demanding judgment, watchfulness

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and resource. The boundary between French and British territory was undefined and on the inland borders the French for some time had been displaying unusual activity. Shortly after his arrival Sir Henry was sent on a special mission to the hinterland in connection with the situation which had arisen, and there he handled a delicate and troublesome business with distinction to himself and advantage to his country. In the following year, when the boundary questions at issue were settled by the Anglo-French Convention, Sir Henry received the thanks of His Majesty's Government for his services, and the assistance which he had rendered was further recognised by his promotion to K.C.M.G.

But the long months of hard and anxious work and the unhealthy climate of West Africa overtaxed even his strong constitution. His health broke down, serious illness followed, and in 1898, within two years of his appointment to the Colony, he was invalided home. Later in the year, when his health had somewhat improved, he was transferred as Governor to the more bracing climate of Newfoundland where he made acquaintance for the first time with a Colony enjoying responsible Government. He remained in Newfoundland for two and a half years, co-operating whole-heartedly with his Ministers in the tasks of Government and devoting himself with characteristic energy to all that affected the welfare of the island and the amelioration of the lot of its inhabitants. His services in Newfoundland received official recognition in 1900 by his appointment as an Aide-de-Camp to the Sovereign, and when, in the following year, he was promoted to the important Governorship of Natal his departure called forth universal expressions of gratitude and regret.

Soon after his arrival in Natal Sir Henry had the honour of entertaining their Majesties the King and Queen, at that time Duke and Duchess of York, who visited the Colony in August 1901 in the course of their progress through the Empire. In South Africa, the Boer war was still in progress, and the first year of Sir Henry's administration was occupied in dealing with a number of difficult problems incidental to the existence of a state of warfare in the neighbouring territories. By this time Natal itself had been freed of the Boer forces, and with the exception of a second and short-lived invasion at the end of the year, the Colony was not again called upon to defend itself or to experience a renewal of military operations within its borders. But in many ways the new Governor could render valuable assistance both to the central Government at Johannesburg and to the Commander-in-Chief, and until peace was signed in 1902 Sir Henry was indefatigable in the support which he gave to Lord Milner and to the Military authorities. Beyond the general supervision of the affairs of the Colony, he undertook, at the request of Lord Kitchener and with the concurrence of his Ministers, the personal control of the working

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of the Boer concentration camps which had been formed in the Colony, and his practical common-sense and grasp of detail soon proved their value in increased efficiency of administration and in the improvement of the conditions of life of the occupants.

The return of peace in 1902, which found Natal with some 7000 square miles added to its territory, was followed by a period of industrial and economic depression. The next few years were a time of reconstruction during which the energies of the Government were devoted to the extension of communications and the development of the natural resources of the Colony. The harbour works at Durban were improved and railways were pushed out in various directions. A line to the Zululand coalfields was opened by the Governor in 1903, and in the same year the railway to Vryheid and the recently incorporated territories was completed. Railways were also built to the eastern portion of the Orange Free State, affording in this way new outlets for the Colony's exports and increased facilities for its transit trade.

But the clouds were soon to gather again, and a year or so before his departure from Natal Sir Henry was called upon to deal with an internal situation of grave danger to the Colony. Rumours of native unrest, both in Natal proper and in Zululand, had been rife for some time. Dinizulu himself, a son of the last of the Zulu Kings, was believed by many to be disaffected, and although he remained ostensibly loyal, a change of attitude on the part of the natives towards the European population which had been discernible since the conclusion of the Boer war was becoming more and more apparent. Of this changed attitude Sir Henry had personal experience on one occasion when, in the course of a tour on the Zululand border, two tribes which he had summoned to an indaba showed deliberate disrespect by appearing before him with fighting shields and in full war paint. The immediate sequel to this incident was unexpected. Not until the weapons had been withdrawn to the foot of a neighbouring hill would Sir Henry receive the chiefs, and he then interviewed the tribes separately. At the close of the audience, the first of the two tribes to be dismissed, succumbing to temptation, collected not only their own but their neighbours' weapons as well and so made off, leaving their indignant friends to discover the loss later on, and to plan measures of revenge which resolved themselves the same night in a faction fight between the two tribes.

The causes of unrest were many and deep seated. There were admittedly serious defects in the machinery of native administration, more particularly as affecting taxation, compulsory labour and debt. Further, the growth of the Ethiopian movement which, religious in origin, had assumed in its development many of the characteristics of a secret political organisation, itself furnished evidence of the

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growing sense of union among the natives of South Africa and provided in some quarters a convenient cloak to cover seditious teaching. To these and other causes must be added a general loosening of control for which the Boer war was to some extent responsible, and the damaging effect on European prestige occasioned by the success with which, on at least one occasion, a native force had retaliated on a cattle raiding Boer Commando. The taunts, too, of their women-folk directed against a generation of natives which had not "blooded its assegais" furnished a further incitement to violence, which soon manifested itself in the killing of pigs, white goats and other animals, and in the ominous organisation of hunting expeditions serving as a mask for military training. The passing of an Act by the Natal Government in 1905 imposing a poll-tax on adult males further fanned the prevailing discontent and formed the immediate pretext for, although it was not the ultimate cause of, the rebellion which ensued in the following year. The storm broke early in 1906. In February of that year an armed native force attacked a party of Police who were collecting poll-tax within a few miles of the capital. Two of the Police were killed, and the fire of rebellion which had for long been smouldering, burst into flames and spread through the Colony and over the border into Zululand. Martial law was immediately proclaimed; the local forces of the Colony were mobilized and were re-inforced later by a detachment of troops raised and sent by the Transvaal Government.

At the end of March an incident occurred which, for a moment, led to misunderstanding with the Imperial Government. Twenty-four natives who had been implicated in the attack on the Police had been tried by court martial and twelve of their number were sentenced to death. After a careful review of the evidence, Sir Henry confirmed the sentences and reported his action to the Secretary of State. The next day Lord Elgin telegraphed for detailed information and instructed Sir Henry in the meanwhile to suspend the executions. The Natal Ministry thereupon resigned, on the ground that the action of the Imperial Government in ordering suspension was an interference with the rights of a Responsible Government. But the misunderstanding was transitory. The scrupulous care with which Sir Henry had examined the cases of the condemned men, and the jealous regard for his responsibility in the matter which had earlier sought and obtained from Ministers an assurance that they had no intention or wish to infringe the perogative of the Crown, convinced Lord Elgin. On March 30th the Secretary of State telegraphed to Sir Henry that His Majesty's Government recognised that "the decision in this grave matter rests in the hands of your Ministers and yourself" and the Natal Ministry resumed office. Three days later the condemned men were executed.

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Into the constitutional question involved it is not here necessary to enter. It was true that an Indemnity Bill for acts performed in the Colony under Martial Law would ultimately require the assent of the Crown and that to this extent the responsibility of the Imperial Government was involved ; but in Natal, where feeling ran high, opinion was unanimous that intervention from England in an act of internal administration, advised by Ministers and confirmed by the Governor in the exercise of his perogative, established a dangerous precedent, paralysing to the authority of the local Ministry and striking a blow at the roots of self-government itself. That this view was shared elsewhere is evidenced by the fact that the Governments of the Australian Commonwealth and of New Zealand telegraphed their anxiety to the Secretary of State and asked to be reassured as to the position adopted by His Majesty's Government.

It was not until the following September that the rebellion was suppressed. During the anxious months that intervened Sir Henry's counsel and advice were eagerly sought by and freely given to his Government, and the critical period of conflict only served to demonstrate the complete accord and understanding which existed between his Ministers and himself. In the exercise of his responsible duty he had early directed that all proceedings of Courts-martial should be submitted to him for confirmation or revision, and throughout the rebellion, until the abrogation of martial law, he investigated personally and with scrupulous care the details of each separate trial, weighing the evidence, taking count of mitigating circumstances, commuting sentences wherever possible and exercising by his authority a moderating influence. To this influence were in no small measure due the determination and self-restraint with which the emergency had been met, and when at last, the danger over, Lord Elgin telegraphed the congratulations of His Majesty's Government to the Colony, the telegram ended on a personal note of acknowledgment of the success which had attended Sir Henry in the execution of his difficult task.

Within a few months of the end of the rebellion Sir Henry, who three years earlier had been created a G.C.M.G., was appointed to the Governorship of Ceylon. But before he left the Colony he had found time to traverse the wide field of native policy and to appoint a Commission of Enquiry into the causes of disaffection and the grievances of the native races. His departure which was regretted by a host of friends and deplored as a real loss to the Colony occasioned an unusual compliment in the shape of a formal request by Ministers for the extension of his term of office.

Ceylon, where Sir Henry arrived in August 1907, furnished abundant scope for the exercise of his great administrative gifts. Fertile, prosperous and financially stable, with a small public

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debt and a surplus fund of over a million pounds, the Colony was ripe for a vigorous policy of development, and Sir Henry applied himself without delay to the preparation of a large programme of public works designed to touch the most salient points affecting the commercial and industrial welfare of the community. The extension of rubber cultivation and the growing agricultural prosperity of the island called aloud for fresh means of access to the ports and markets. The vital importance to trade and agriculture of developing communications was ever present in Sir Henry's thoughts, and his professional military training no less than the natural trend of his mind fitted him in a peculiar measure to appreciate the practical possibilities and requirements of the time. New railways were opened to the rubber and cocoanut-bearing districts, and the construction of roads proceeded at a pace regulated only by the length of the Colony's purse and the capacity of the Public Works Department to deal with new undertakings. With a lively appreciation of the influence of material prosperity on moral well-being, he endeavoured by all means in his power to extend the cultivated area of the island, and he spared neither time nor thought if, thereby, the stubborn earth might be subdued to the needs of men, if, with his help, the wilderness might blossom and the solitary places rejoice. The whole problem of the agricultural well-being of the island was a constant care to him. He re-modelled the Botanic Gardens Department and enlarged it into a Department of Agriculture with a scheme of agricultural development including facilities for training teachers in village schools and the provision of agricultural scholarships. He found time to enquire into the financial condition of the native peasantry, and the recommendations of a Committee appointed to report on the introduction of agricultural banks led to the introduction of agricultural co-operative credit societies on the lines of societies already existing in India. Questions of land settlement and survey, with their intimate relationship to agriculture, also passed under his review. The work of the Survey Department was practically re-cast and he was responsible for the introduction in 1909 of a Landmarks Ordinance, providing for the permanent marking of boundaries, which, by protecting purchasers of land from the encroachments of their neighbours, conferred an inestimable benefit upon the public.

But of all his activities, there is none by which he will be better remembered in Ceylon, as there was assuredly none more important, than the share which he took in the development of the harbour works of Colombo and in the provision of increased facilities for handling the trade of the port. Schemes of a widely differing nature for connecting the harbour with the Colombo lake had from time to time been projected and abandoned, and even before his arrival

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in the island Sir Henry had begun to study the subject. Personal familiarity with the conditions obtaining only strengthened his conviction of the necessity for some such undertaking, and in due course a considered scheme was included in his original programme of works. This scheme was later referred to a Commission and in some respects modified. In its final form it received the approval of the Legislative Council in 1910, and before he left the Colony Sir Henry had the satisfaction of knowing that work had actually begun. Other important improvements to the harbour were also effected under his instructions. The increased protection which an extension of the South West breakwater afforded, by liberating a valuable area of land led to the inception of an extensive scheme of works, including additional jetty and wharf accommodation; the breakwater itself was further protected; arrangements were made for deepening the harbour, and railway facilities in the port area were increased and new yards erected.

Sir Henry's term of office was noteworthy also for the constitutional changes effected in the Government of the Colony. Not only was the Legislative Council re-modelled and enlarged but the elective principle was introduced for the first time in the history of the Island. Hitherto, all members of the Legislative Council had either sat *ex-officio* or had been nominated by the Governor, but in 1910 an Ordinance was passed providing for election by ballot of four unofficial members representing the communities educated on European lines.

As was only to be expected, Sir Henry displayed great interest in the Volunteer Force of the Colony and, from first to last, he actively concerned himself in all that made for the improvement of its organisation. He was largely responsible for the formation of an Engineer Volunteer Corps which proved a signal success, and the general advance in the efficiency of the various branches of the service during his administration was in no small measure due to his encouragement and to the changes which he introduced. It is not possible here to make more than a passing reference to the innumerable outlets which Sir Henry found for his abundant energy. Public health benefited under his rule by the expansion of the medical department, by the attention directed to the erection of hospitals and dispensaries and by measures adopted to combat disease. The importation and distribution of opium were placed by Ordinance under direct Government control, and the sale of native intoxicating liquors was regulated by the creation of an Excise department, controlling manufacture and consumption on the lines of a system which was already working satisfactorily in Madras. Police work was reviewed and developed, and the prison system of the island amended by the adoption of measures for improving the condition of prisoners and by combining the teaching

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of trades with the deterrent effects of punishment. Among other activities of his busy administration may be mentioned the completion of schemes for the supply of water to small towns, the revision of postal and telegraph rates and regulations, the establishment of trunk telephone lines and the consolidation of the game laws.

Enough has been said to give some idea of the constant care and thought which Sir Henry devoted to the interests of the Colony, and of the boundless energy with which he sought continually to promote its prosperity. And when the end came, when at length, broken in health, he left for the last time the island which he had served so well, he could look with satisfaction to the results of five and a half years of unremitting toil and render with confidence and pride a final account of his stewardship.

To the tasks of Government Sir Henry brought many great qualities. With his considerable professional attainments as an Engineer and the specialized knowledge acquired in his military training he combined great natural ability, keen insight, and quick sympathy. Possessed of a strong will and a fearless courage which neither popular clamour nor personal interest could shake, those who served under him and the peoples over whose destinies he from time to time presided had good reason to know that in Sir Henry McCallum was a man who, above all else, could govern. During a long and distinguished career in many lands and under differing conditions, he gave his whole strength to the varied tasks allotted to him, and in the countries of his adoption and the familiar places of his life there are many to-day who can testify not only to the energy and administrative capacity which marked his work, but to the great personal qualities of character which fitted him pre-eminently for the high offices of Government.

Among the virtues which make for successful administration there is none which Sir Henry valued more greatly or cultivated more assiduously than justice. In his public life and his private relations alike he was essentially a just man. Fair dealing was an article of his creed, and when at last the reins of Government fell from his hands, it was by the standard of justice that he wished his actions to be judged. When, in his farewell message to the Legislative Council of Ceylon penned at the end of his career, after summarising the results of his administration he wrote that " I have held steadily before me the scales of justice in my dealings with all independent of colour, creed or occupation " it was more than the past six years of office that his thoughts embraced. Rather, his words expressed the constant endeavour and aspiration of his mind, the ideal which, through the trials and achievements of his working years, he had kept steadily before his eyes. Of the exacting standard of duty which he set himself, his ceaseless vigilance, his untiring devotion

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to the welfare and interests of those who were for the time being his subjects, the present writer who for many years was privileged to share his confidence can abundantly testify. No man ever gave himself more freely to the service of his country, and the unsparing toil, the courage and the zeal with which at all times he faced and handled the problems confronting him gained their reward in the confidence and affectionate regard of men of diverse races and various creeds. Giving much himself he expected much of others, but if he exacted from those who served him something of the energy and the consuming zeal which inspired his own life in the conduct of affairs, no man was ever more considerate to his subordinates and assuredly no man was ever kindlier as a friend. A born leader of men, no opposition daunted him and no difficulties dismayed, and the regard for justice, the singleness of vision, and the tenacity of purpose with which he met situations of difficulty and danger inspired trust and confidence in those he governed and revealed his character in times of stress as an influence enduring and steadfast among the faltering hearts of men.

His memory will be green in the hearts of many friends to whom his death has brought an abiding sense of loss, and all who knew him and those, in many lands, who learnt his merit will mourn a man loyal in friendship, wise in counsel,

"Strong in will,
"To strive, to seek, to find and not to yield."

ARTHUR HEDGELAND.

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CORRESPONDENCE.

THE WORD "GADGET."

A correspondent writes:—This useful word cannot be found in any standard dictionary. The only one that throws any light on it is the Oxford Dialect Dictionary which contains the following:—

GADGE (*Yks*) Sewing term: to baste; to run or tack together lightly with long stitches.

(*W. Yks*) "Gadge me these trousers up."

(*Norf and Suffolk*) To measure, to ascertain the dimensions of, estimate. "I gadge up this allotment at ¼ acre."

Both dialect meanings apparently indicate a hasty extemporized operation.

Can anyone throw any other light on the origin of this useful little word. Perhaps the author of the following lines which were circulated in France could do so?

"All things bright and beautiful
"Gadgets great and small
"Bombs, grenades and trench boards
"The Sapper makes them all."

(NOTE.—Webster's New International Dictionary gives the following:—
Gadget—A contrivance, object or method;—often used of something novel or not known by its proper name. *Slang*.—ED. *R.E.J.*)

REVIEWS.

A SHORT HISTORY OF THE GREAT WAR.

By PROFESSOR A. F. POLLARD, M.A., LITT.D. (Methuen). 10/6 net.

This book, which has been written for the use of students, is to be recommended as such on account of its clear narrative, abundant and carefully prepared maps and well-informed criticism of events, the true details and motives of which are still but imperfectly divulged.

F.E.G.S.

MATHEMATICS FOR ENGINEERS—PART II.

By W. N. ROSE. (Chapman & Hall.)

This book fairly justifies the claim contained in the editorial notice that it occupies a position intermediate between treatises on the Calculus of a purely mathematical character, and those which merely illustrate its physical applications. Many practical problems are worked out in the text, and there are useful chapters on Fouriers theorem, Differential equations, the solution of spherical triangles, and the theorem of Least Squares. A feature of the book is its clear text and excellent diagrams. The exercises set are instructive and there is much useful information within a moderate compass. The treatise supplies a want.

J. M. WADE, *Lieut. Col.*

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MAGNETISM AND ELECTRICITY.

By BROOKS and POYSER. (Longmans, Green & Co., 1918).

It is stated in the preface that this work is intended to afford such a range of general reading in the subject as is desirable for the majority of students before they begin to specialise either in pure science or in the various branches of electrical engineering, and this gives a very fair indication of the scope of the volume. The first eight chapters deal in detail with the subject of Electrostatics and Lines of Electric Force, while the next five are devoted to Magnetism and Lines of Magnetic Force, and these two sections certainly seem to prepare a student thoroughly before he sets out on the third and biggest section, viz.: Current Electricity. In this latter section the elementary principles relating to flow of current, electro-magnetic induction, and magnetisation are first considered fully. Then come chapters on the theory of Alternating Currents and Measurement of Inductance, followed by short dissertations on the subject of Thermo-electricity, Passage of a discharge through gases, Telegraphy, Telephony, Dynamo and Motors, Lamps, Measuring Instruments, Units and Dimensions, and finally, Electric Oscillations and Wireless Telegraphy and Telephony. A feature of the book is that the experimental method of illustrating and explaining all points as they arise is adopted and the student is thereby encouraged to prove for himself the truth of all that he reads. Apparently, however, the book is merely a reprint of the 1912 edition, with the addition of an appendix on Wireless Telegraphy and,where much is good, it seems a pity that no effort has been made to bring it up to date on some minor points. For instance the chapter on lamps makes no mention of the half-watt lamp.

G.T.

PAGES D'HISTOIRE, 1914—1918.

(Librarie Militaire Berger-Levrault, 5—7 Rue des Beaux Arts, Paris).

(*Continued from R.E. Journal for April*, 1919).

The 156th number of this series contains the official communiqués issued by the Central Government at Paris to the Provincial Authorities in France during the three months, April to June 1918; it is the XXXVII volume dealing with such matters. In an Appendix are contained extracts from the *Journal officiel* relating to the visit, in the early days of April, of the President of the French Republic to the Armies fighting in the region of Montdidier and to the messages which passed, in the month last mentioned, between the Sovereigns and the chief of the Allied and Associated Powers and the President of the French Republic.

The 157th number is entitled *Le Front*, sub-title *Les Étapes de la Délivrance*; it contains a series of coloured maps showing the Front in the Western Theatre at the following periods:—5th September 1914; after the victory at the First Battle of the Marne, 31st December 1914; the "stabilised front" 1915 to 1917; 20th March 1918; 16th July

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1918; 3rd August 1918; 3rd September 1918; 25th September 1918; and the 15th October 1918. This number is in continuation of the 39th volume of the series.

The 158th number is entitled *L'Épopée de Zeebrugge et le "Vindictive."* The author of the volume is Keble Howard (J. Keble Bell, Sec.-Lieut. R.A.F.); he gives in ten short chapters a brief account of the brilliant feat carried out on the eve of St. George's Day 1918 by the British Navy which resulted in the bottling up of German submarines in the Bruges Canal by the sinking of the *Iphigenia* and the *Intrepid* in the Entrance Channel to Zeebrugge Harbour. The account of the affair appears in the volume in the form of interviews with some of the prominent actors in this daring naval raid. We are introduced in turn to Captain Carpenter; Captain Sandford; Sergeant Finch; and Captain Chater. The volume is illustrated. A chart showing the entrance to Zeebrugge Harbour, and also aerial photographs of the same, in which the obstructions caused to the fairway are to be clearly seen are contained in the volume. Other photographs consist of portraits of Admiral Sir Roger Keyes, Captains Carpenter and Sandford; views are also published of the *Vindictive*, etc. French translations of the official accounts of the operations against Zeebrugge and Ostend are also included in the volume. It was in connection with the latter operation that the *Vindictive* was, in May 1918, finally sunk in Ostend Harbour; a brief reference to this is also contained in one of the Chapters of the Volume.

The 159th number of the series is entitled *L'Alliance Franco-Russe*; it is in fact a reproduction of the Third Yellow Book relating to the Great War issued by the French Government. The volume is divided into four chapters and contains a reprint of 107 despatches with, in some cases, the appendices which accompanied them. In Chapter I are disclosed the steps by which the Franco-Russian Alliance was brought into existence; the correspondence in relation to the preliminary negociations is contained in 27 despatches, which extended over the period 24th August, 1890 to the 30th January, 1892, inclusive. The situation was a delicate one and unfortunately, at the time, M. de Giers, the Russian Foreign Minister, was suffering from a serious illness, which added considerably to the difficulties met with. In Chapter II is set out the correspondence relating to preliminary steps taken to frame a Military Convention to regulate the military assistance to be mutually provided by the High Contracting Parties in furtherance of the Treaty of Alliance between them. This part of the correspondence consists of 55 despatches covering the period 4th February, 1892, to 5th November, 1892, inclusive. In order that secrecy should be maintained in relation to the Alliance being then negotiated for as long as possible, it was decided that no special mission should be sent from France to Russia, or vice versa, for the purpose of discussing the terms of the Military Convention. However, an opportunity was created by the Military Manœuvres, carried out in Russia in the autumn of 1892, to bring high officials of the French and Russian Armies together: they were thus able to discuss the details of the Military Convention and to come to an agreement as to its scope. For this purpose, General de Boisdeffre proceeded in the August of the

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year mentioned to St. Petersburg ostensibly to attend the manœuvres, but really to get into direct touch with General Obroutcheff and the Russian General Staff with the object of elaborating the framework of a Military Convention. Some difficulty was experienced in arriving at a formula acceptable to the representatives of the two nations. In Chapter III is contained the correspondence which followed in relation to the Military Convention after General de Boisdeffre and General Obroutcheff had laid the foundations of the same; it consists of 15 despatches covering the period 20th May 1893 to 12th August 1899. Finally, in Chapter IV is published the correspondence relating to the Naval Convention between the two countries. The first despatch of this series is dated the 6th February, 1912, and the last the 16th August 1912. The original text affords valuable instruction and indicates how extremely difficult it is for a democratic government to negotiate an alliance with another Power, even where the forming of such an Alliance is vital to the continued existence, as an independent Nation, of the country it represents.

The 160th number is a Diary of the War for the period 1st January to 30th June 1918. It is the eighth volume of the series dealing with such matters.

The 161st number is entitled *Les Glorieuses Journées de Lorraine et d'Alsace*. The volume contains an Introduction by M. R. Steinheil and is divided into three parts. In the first part is contained an account of the proceedings in the French Chamber of Deputies at the meeting held on the 11th November, 1918, when the French Premier announced that an armistice had been concluded by the Allies with the Central Powers. In this part are also published the texts of Marshal Foch's Proclamation to the Allied Armies dated the 12th November, 1918, and of the speech delivered by the President of the French Republic in Paris on the 17th November, 1918, when he reviewed the achievements of the War. The second part contains the texts of the Proclamations issued by the newly appointed Commissary of the French Republic at Metz, by the Mayor of Metz, and by General Gouraud on his arrival at Strasburg on the 24th November, 1918, and also the texts of the Army Orders issued by Marshal Pétain and by General Gerard after the signing of the armistice. In this part are also published the texts of the speeches delivered at Metz, Strasburg, Colmar and Mulhausen, on the occasion of the triumphal visit of the President of the French Republic and the Premier to the recovered Provinces. The third part contains an account of the meeting of the Chamber of Deputies held, on the 12th December, on the return of President Poincaré, M. Clémenceau, and the other Ministers from Alsace-Lorraine for the purpose of celebrating with due solemnity the restoration of French rule in the recovered Provinces.

W. A. J. O'MEARA.

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NOTICES OF MAGAZINES.

THE MILITÄR-WOCHENBLATT.

December, 1919.

No. 66.—*The Officers Pensions Law and the necessity for amending it*—A strong appeal for the amendment of the pensions Laws of 1871 and 1896. The writer maintains that those officers who came forward from retirement during the war and held, in the field, rank higher than that with which they originally retired, should have their pensions based on the higher rank.

France and England in Syria.—The article consists of extracts from the French press and adds such comments as are calculated not to improve French feeling on the question.

The *Militär-Wochenblatt* appeals to all members of the old "undefeated" German Army to hasten the formation of Regimental Unions and gives a list of those which have been formed during the last month, which brings the total up to 80.

Roll of Honour.—Infantry Regiment No. 53: 139 officers killed, 3 died of disease and 11 missing, other Ranks 2,750 killed. The heavy losses in senior officers in the early weeks of the war are noticeable, as are also the losses against the French at Perthes in September 1915 and on the 21st and 22nd March 1918 near St. Quentin.

No. 67.—The leading article headed *Approaching Dangers* is a protest against the draft of the new pensions law for officers and officials. Those parts of it which propose to take into account the officer's private means in assessing his pension are described as pure robbery and the writer comments bitterly on the doubtful pleasure of living in a so-called socialistic state.

The Corps of Officers and German Society.—The writer maintains that the abolition of the Officers Courts of Honour, decreed in August 1919, is a blow not only against the Officers Corps and the memory of those who have fallen, but also against the whole of German society. He states that this Society will regulate its code of honour by that of the Corps of Officers and is already longing for the re-erection of the old standards of truth and faith; and concludes with an appeal to all Officers Associations to do their best to set them up once more.

The National Union of German Officers appeals to all to support and subscribe to a presentation to Field Marshal Von Mackensen on his return to Germany, which shall make up to him for the humiliations to which he has been subjected.

The French Railways in the War is a reprint without comment of an article on this subject in *The Times* of 6th Sept. 1919.

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Gazette dated 24th November, 1919, gives the names of the members of the Reichswehr Ministry. These include—Major-Gens. Reinhardt; Von Seeckt; Von Braun; Eisenhart-Rothe; and Cols. Kress Von Kressenstein; Wurtzbacher; and Hene.

Memories of the Great War, by General Conrad Von Gossler, G.O.C. VIth Res. Corps, is reviewed with particular comment on the fact that in 2½ years but few days passed when the author did not visit his troops in the line. The reviewer particularly wishes to bring this to the notice of those who imagine that the higher commanders spent their days in ease and comfort.

Roll of Honour.—Pioneer Battalion No. 14: 36 Officers and many other ranks killed.

No. 68.—*Bulgaria in the Great War—A reply.*—Dr. Freiherr Von Friesen declares that Radowslavow's statements concerning the German Army and its higher command are untrue and unjust and that they must be sharply repudiated. By the treaty concluded with Roumania on the 7th May, 1918, Roumania was obliged to surrender her gains of 1913 in the Dobrudja as well as to submit to a further rectification of the frontier in favour of Bulgaria. The northern part of the Dobrudja became the condominium of all four allies because Bulgaria had not yet been able to make up her mind to give Turkey the ground west of Adrianople, and on the Maritza. Germany, who had performed most of the hard work, contented herself with certain economic advantages. Ferdinand is said to be rightly described as a politician with two irons in the fire and though he and Radowslavow sympathized with Germany, they waited to see who was going to win before they cast in their lot with either side. With Bulgaria it was not a war with existence at stake, but rather one of expansion and of revenge against the hated Serbians. Hindenburg's 1915 campaign and especially the fall of Warsaw were the deciding factors, and in September she approached the Central Powers and asked for strong German and Austrian Military support for her attack on Serbia. Radowslavow's assertion that these were also for ultimate employment against Greece and Roumania is disproved by the fact that as yet neither of these powers had entered the war, and above all by the consideration that Germany was at that time in no position to promise troops in any but limited numbers for limited objectives. Germany, in actual fact, gave all and more than she promised, and, with Austria, conquered Serbia for Bulgaria. By this time the losses on the Somme and the wavering attitude of Roumania compelled Germany to withdraw the greater part of her troops and to hand their conquests over to Bulgaria. These were purely military measures, which Ferdinand, unfortunately no soldier, did not understand and protested against, in spite of the fact that Roumania had now to be dealt with. Bulgaria gave but little help in the conquest of Roumania, but Turkish Divisions, offered by Enver, were gladly accepted; Ferdinand, however, deprecated their value and protested against their use, though it was due to the indifferent performances of his own troops in Macedonia that he had himself insufficient to spare for the conquest of the Southern Dobrudja and the accomplishment thereby of his greatest ambition. In the event the

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Turkish troops did very well and such Bulgarian formations as were employed in the Dobrudja were rather disappointing; "according to Ludendorff, who ought to know and has no prejudices." However the Bulgarians were not by a long way entirely deprived of German help. Nearly a whole German Division remained on the Greek frontier, and money, munitions and aeroplanes were freely given. In addition several Jäger Battalions, which were really required in Roumania and—last, but by no means least—the invaluable guidance of General Von Scholz, were lent. In spite of all defeats Roumania only accepted peace in the spring of 1918 and Radowslavow blames the German Army Commanders for this and for those parts of the treaty which did not please him, saying that it was all due to their interfering with politics, a subject which they did not understand. The writer warmly denies that the Generals usurped the rôle of the diplomatists, puts all the bad points in the treaty down to the latter and asserts that the former were right in all their criticisms. Radowslavow's assertion that, on the collapse of Bulgaria, plenty of German and Austrian troops appeared which had hitherto been asked for in vain, is next dealt with.

It is true that in June, 1917, Ferdinand had appeared at Kreuznach, but at that moment and still more in the spring of 1918 it was impossible to spare reinforcements. When Bulgaria eventually broke, Germany and Austria did each manage to send 2 Divisions to Sofia and Serbia, and in addition the picked Alpine Corps was set in motion from the West. If these came too late, it was due partly to bad transport conditions, but still more to the lack of resistance offered by the Bulgarian Troops; "The Bulgarian Army went home" said Ludendorff, and the writer has it direct from Germans who fought in the Alpine Corps that the harshest criticism of the Bulgarian Army is justified. In conclusion the writer asks whether it was reasonable to expect that Germany should expose herself to invasion by the armies of France, England and America, merely to ensure that Bulgaria's greed of conquest should be gratified. Radowslavow states that the German Generals knew nothing of the art of politics; it should rather be said that he knew nothing of the art of war.

German Admiralty in the War comments on the recriminations started by von Tirpitz's Memoirs, and blames him unreservedly for his failure to establish in time of peace for the supreme direction of Germany's naval power. Such a state of affairs as regards her army would have been inconceivable. He saw the necessity and failed to meet it, because, he says, he could not bring himself to ask for his own advancement. Tirpitz expressed his surprise that, on the outbreak of war, the naval plan of campaign had not been discussed with the Army. The writer says that such an admission could only in circumstances like the present pass almost without comment.

No. 69.—*The German-Turkish expedition against the Suez Canal in* 1916 *by Captain Von Heemsterck.*—The writer gives a short account of the attack of February, 1915, wherein he says that five Turkish battalions reached the western side of the Canal. The whole adventure showed that nothing could be done without long and careful preparations which were begun in 1915, but, owing to the bad communication with

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Germany, whence all technical material had to come, these were much delayed. The attack on the Yeomanry at Katia on Easter day, 1916, is described as a premature pin-prick, which merely drew England's attention to her danger, and made her strengthen her defences. When the Turks made their attack in August, 1916, their howitzers which had been delayed in coming from Germany, stuck in the sand and only two batteries got into action. No details are given of the action, but the German Flying Corps is highly praised. Eighteen months later the German Engineers finished the Amanus tunnels and ran a light railway over the Taurus, and, as the writer remarks with some bitterness, at the same time British officers were going from Jerusalem to Egypt, on leave, with dining cars and sleeping berths, in 36 hours.

Military and political events in Russia.—It is stated that all the indications go to show that England intends to come to terms with the Bolshevists, having failed to defeat them by force of arms. France is said to be alarmed at this and to fear that her beloved Poland will come off badly and that Germany will derive advantage from the result.

Signs of the Times is the heading given to an advertisement copied from a provincial paper, which offers situations as night watchmen and says " Ex-Officers preferred."

General Maurice's article on Disarmament in the *Daily News* of 29th Nov. is very fully quoted but without comment.

No. 70.—*Contribution to the History of the War.*—This instalment deals with M. Painlévé's article " The Truth about the offensive of 16th April, 1917."

The Military and political events in Russia.—This article explains the disastrous consequences to Yudenitch of the secession of Esthonia from the anti-Bolshevist combination. The favourable situation of the Bolshevist forces is pointed out and England is declared to regard the discomfiture of Koltchak with equanimity. The situation in Russia is alleged to be due to England's wish to establish a strong influence in the Baltic and to weaken as much as possible her historic rival in central and western Asia; to France's hysterical terror of Germany and her strengthening of Poland; and to America's desire to exploit Siberia. The writer asks what will be the result of the short-sighted and selfish policy of these three powers as regards Bolshevism. America, herself already infected with Bolshevism, has rejected all idea of compromise with it, as has also France who wants to pursue her pro-Polish and anti-German policy. England's aims are, as ever, treacherous and selfish. Her ideal is to arrange a Siberian Russia, an Ukrainian and Cis-Caucasian Russia, possibly also a Baltic Russia and a government to include the northern territories of Murmansk and Archangel, all more or less under British protection, with the Bolshevists in the middle. The writer hopes the national pride of Russia and the traditions of her great past will bring all these schemes to the ground.

Lieut. Gen. Von Scriba, Editor of the *Militär-Wochenblatt* for the last 7 years, is giving up the post. He thanks all who have supported him and states that his aim has always been to encourage the study of the science of war and, particularly in these latter days, to uphold the interests of the Corps of Officers and the Monarchical ideal.

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No. 71.—A long extract is given, of the law dealing with the compensation of those officers whose services are no longer required, owing to the reduction of Germany's forces, in accordance with the peace treaty.

Contributions to the history of the War is a second article dealing with M. Painlévé's account of the events preceding the French offensive of 16th April, 1917.

A few vacancies in Municipal and Police services are offered to ex-officers. The pay varies from about 6,000 to 10,000 marks per annum.

Roll of Honour.—Bavarian Infantry Reg. No. 142: 63 Officers and 2,843 other ranks killed. Out of 7 Captains and higher ranks, 5 fell in the first month of the war.

No. 72.—A leading article on the general military and political situation regrets that Germany has not half a million reliable troops at her disposal. If she had things would be very different. France says she is still well armed, but only in order to reduce her still lower than at present. Chauvinist France regards the League of Nations with anxiety, fearing that when Germany is admitted to it, the Treaty will be revised. Germany's ruin is attributed to President Wilson's hypocrisy, and he is described as the most revolting type the war has produced. The question of one or two years' service in France is discussed and mistrust of America on the part of the French is alleged. Mr. Churchill's estimate of the present armed forces of Germany is said to be 20 per cent. too high, but even so France will not believe it, and regrets that she withheld the *coup-de-grâce* when it was within her power to give it, and so on. General Maurice's *Daily News* article on Disarmament is again quoted with evident satisfaction.

The River Ourcq in the War.—Lt. Gen. Von Görz discusses the part this river played, particularly in protecting the German flank during the evacuation of the Chateau-Thierry salient in July, 1918.

German East Africa in the War—A book by Dr. Schnee is very well reviewed. It states that no less than 2,600 kilometres were covered in ten months under great difficulties with constant fighting, a feat unsurpassed even by Xenephon.

Roll of Honour.—Field Artillery Regiment No. 60: six Officers and many other ranks killed.

L. CHENEVIX-TRENCH, *Major, R.E.*

REVUE MILITAIRE GÉNÉRALE.

October, 1919.

THE GERMAN ARMY BEFORE AND DURING THE GREAT WAR (1914—1918).

The article on the above subject begun in the number of the *Revue* for August—September, 1919, is continued in the number under notice.

The General Mobilisation. The fact that a general mobilisation had been ordered was *made known* throughout the German Empire on the

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evening of the 1st August, 1914. The first day of mobilisation was fixed for the 2nd *idem* (a Sunday); on this date, however, all units, etc., in the frontier zones had already been made up to their war establishments, and had also brought their "field grey" into wear. The arrest of persons suspected of being spies began at once, i.e., on the 1st August; some of the unfortunate individuals who came under suspicion were tried, condemned and shot out of hand in a truly German fashion; no doubt to strike terror in the hearts of those who might be engaged in this dangerous work, and could not be discovered. Details are furnished by M. Camena d'Almeida in the original article in relation to the classes called up and the progress of the German mobilisation.

The Establishments of the Combatant Units. Under this heading is given information relating to the numbers of reservists required to bring units up to their fighting strength; the departure of formations for the front; the formation of Reserves and mobile Ersatz units; and the utilisation of trained soldiers for building up Reserve and Ersatz units. Tables accompanying the text of the original article provide information relating to the composition of several of the Reserve and Ersatz formations, and show the regions from which the men composing them were drawn.

Artillery Matters.

The article on the above subject by General Le Gallais begun in the *Revue* for August—September, 1919, is continued in the number under notice. Chapter I is brought to a close with a Section dealing with the factors which have introduced a new element in modern war, viz. Liaison; Aviation; and Tanks. Each of these matters is briefly discussed in the original article. Chapter II deals with *The Employment of Artillery*. In a brief introduction to this subject General Le Gallais points out that during the Great War there was nothing in connection with the employment of artillery which, so far as his experience goes, was in conflict with the general principles laid down in the latest French Regulations, viz.:—those issued in 1910 or 1911. In a Section dealing with the "War of Movement," General Le Gallais calls attention to the fact that the German infantry and artillery suffered heavy losses from the French "75" guns; the former because it neglected during its advance to make the best use of the *terrain*, and the latter because it did not come into action in *masked positions*, and also because it neglected, when in movement, to draw all the advantages it might have done from the lie of the land. It is stated that all that could have been expected from the artillery was actually obtained from it, owing to the fact that rational methods sanctioned by experience were consistently adopted. (*To be continued*).

German Opinions on the War.

The sub-title of the original article is *Deductions of the World War by Lieutenant-General von Freytag Loringhoven*. In a short Introduction a very brief outline is given of General von Freytag Loringhoven's military career. It is pointed out that very few copies of his book,

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Deductions of the World War, a translation of which forms the text of the original article, got across the frontier; dealing as it did with the German plans for the next Great War, it contained a too candid exposure of Teutonic aims, so the export of the book was naturally forbidden by the German authorities. Chapter I deals with the political and economic position of the Central Powers. It is stated that the grouping of the Powers at the beginning of the Great War, and during its continuance, proved extremely disadvantageous to the Central Powers: indeed, it is necessary to go back to the desperate position in which Frederick the Great found himself during the Seven Years War to find anything comparable to the straits to which Germany and Austria were reduced during their late struggle in Europe. It is pointed out that it was Great Britain that succeeded in maintaining accord between the Entente Powers and binding them closer together, when the difficulty of destroying the Central Powers came to be fully realised. The favourable position which Great Britain occupied in the spheres of International Politics and Economy proved peculiarily advantageous to her. So far as Germany is concerned, being up to the period of the 1870 War practically an agricultural State, during previous European wars questions relating to International Politics and Economy were of secondary importance. However, owing to the development of her commerce and the growth of her population such questions became, at the outbreak of the late War, of prime importance to Germany. Measures, it is admitted, were taken to cope with the impending situation, but the preparations, which Germany had made in anticipation of the War, proved to be wholly inadequate: Germany found herself, in 1914 and the subsequent years, not only most disadvantageously situated in relation to the general political situation, but had also to grapple with an economic position which was as difficult as it could possibly be. The consequences of the blockade to which the Central Powers were subjected made themselves felt immediately, although they managed for a considerable time to cope with the situation and to develope their own resources. Nevertheless, there was no way of entirely getting over satisfactorily the disadvantageous situation created for the Central Powers, owing to the Command of the Sea being in the hands of their adversaries. General von Freytag Loringhoven states that Admiral Mahan correctly estimated the influence of Sea Power in relation to present day economic conditions: it was the pitiless use of Sea Power that hastened the economic catastrophe in Central Europe, which resulted in the Armistice of November 1918. Chapter II deals with the psychological effects produced by a national war on the masses. The author of the original article says that the war spirit manifested in the great national armies that took part in the late struggle is something the like of which has never before been experienced in the history of the world; the nearest approach thereto can alone be found in the chronicles relating to the French Revolution. That human beings have, it is pointed out, at all times been susceptible to mass suggestion, is demonstrated by the ease with which religious fanaticism can be fanned; in recent times such susceptibility has, it is suggested, increased. Among the factors which are assumed to have contributed to this increase of susceptibility in the masses are, it is

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alleged, political elections; such elections are said to excite unworthy passions and to destroy all sound judgment. The characteristics of the War, as they present themselves to the German, are briefly reviewed. France, it is said, in 1914, brought for the first time into the field against Germany's national army an army organised on the basis of compulsory service; an army, moreover, in which hatred of everything German had been developed to the highest pitch with the greatest assiduity for several decades, and which had been thoroughly imbued with the idea of a *guerre de revanche*. It is suggested that methods of franc-tireur warfare were adopted in Belgiun with the aid and approval of the authorities, and it was for this reason that the War acquired a character of brutality, a character "which is altogether foreign to the nature of *our* German soldiers." Great as were the *tours de force* in matters of organisation made by Great Britain, she was at no time able to overtake, it is suggested, the initial disadvantages with which she entered the War; that of a voluntary service army. General von Freytag Loringhoven admits that Great Britain attained a high degree of technical efficiency, but, in his opinion, her battle tactics always remained defective. The British Army, after its conversion to a national army, remained an instrument of economic warfare against Germany. No pains were spared, it is said, to work up a spirit of hatred against Germany in England, and such hatred, it is alleged, resulted in the maltreatment by British soldiers of German soldiers—the astounding accusation is made that both British and French soldiers showed themselves capable of much "brutality." The barriers which International Law had erected to assuage the severity of War, were, says General von Freytag Loringhoven, thrown down "under the effort of this new violence." He is naturally careful not to call attention to the initial and principal part which his own countryman played in the upsetting of these very "barriers." (*To be continued*).

JOTTINGS.

The French Legislature has found little difficulty in coming to a decision regarding the ratification of the Treaty of Versailles.

It is stated that the new Government in Germany has created a Ministry of War consisting of six Departments, which are perfectly organised. The Great General Staff has, of course, disappeared. The reduced proportions of the German Army under the Peace Treaty can be readily seen from the subjoined Table:—

	1914	1920
Battalions of infantry	600	63
Battalions of engineers	14	7
Squadrons of cavalry	550	79
Military Budget in millions of marks ..	980	1100(!)

The labour situation in Great Britain, the political situation in Fiume, the financial situation in Czecho-Slovakia, and the state of chaos in Russia are briefly touched upon.

W. A. J. O'MEARA.

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REVUE MILITAIRE SUISSE.

No. 1 *January*, 1920.

ORGANISATION OF THE SWISS ARMY.

Colonel Sarasin points out in the original article that there exists at the present time a very general demand for a reduction in the military obligations imposed on the youth of Switzerland, and also for a reduction in the military budget of the Confederation. He estimates that the minimum expenditure on the Swiss Army, under present day conditions, should be 80 million francs; on the other hand, the Federal Council has decided that the Vote for the Army shall not exceed 40 million francs. Colonel Sarasin discusses the various modifications which should be introduced in the organisation of Switzerland's military forces in order to make the most of funds voted for their upkeep. He recommends that steps should be taken to ensure that only those who are in every way physically fit for military service shall alone be enlisted; this will naturally involve a reduction in the effective strength of the Army, but, as Colonel Sarasin points out, the advantage will be gained of raising the general standard of the *personnel*, and the higher quality of the Swiss soldier will, therefore, be some compensation for the reduction in numbers, which must now inevitably take place. A further recommendation is that although the Landwehr troops should continue to be brigaded as heretofore, on the other hand, they should not be considered as Battle units, but, on the contrary, as the real reserve to make good casualties in the first line units and formations.

THE STRATEGIC POSITION OF SWITZERLAND.

Colonel Feyler, the author of the original article, refers to the wide-spread idea that the mountainous character of a country gives it a special strategic value; he does not agree with this view. However, the Federal Government has advanced this idea in connection with its proposal that Switzerland should, *in the interests of Europe*, be admitted to membership, as a Neutral, to the League of Nations. Colonel Feyler briefly reviews the military significance of Swiss territory in relation to the campaigns which have preceded the Great European War; he gives the reasons which prompted the belligerents taking part in those campaigns, in some cases, to make use of Swiss soil, and in others to avoid it. The position of Switzerland during the critical days of 1914 is examined; as well as the position after Italy came into the struggle. Colonel Feyler shows how it came to pass that Switzerland remained immune from invasion during the Great War. A sketch map, accompanying the text of the original article, shows the disposition of the Italian Army in 1915: one half of it is seen to be massed east of the Tagliamento for the offensive in the direction of Trieste. (*To be continued.*)

THE MILITARY ACADEMY OF ZURICH.

The Academy, which was closed down on the outbreak of War in 1914, has now been reopened. Major de Valliere calls attention, in the original article, to the debate on the organisation of the Academy.

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which took place in the Federal Council in June 1914, when a fear was expressed by the socialists that an institution of the kind in question was the breeding ground of *caste*. Major de Valliere controverts this mischievous suggestion and explains the part that is played by the Academy in the national life of his country. A brief description is given of the Academy and the courses of instruction given there.

THE ARMED FORCES OF THE LEAGUE OF NATIONS.

The original article is a review of a Report made by Major Gaston Moch, of the French Artillery, to the Peace Bureau at Berne; the Report in question has been published under the title *Les forces armées dans la Société des nations* (sold at 1 fr.). Major Moch expresses the opinion—in unequivocal terms—that it is essential that the League of Nations should have armed forces at its disposal; he considers that "the problem of the organisation of the League of Nations is peculiarly a military problem." The various aspects of the question discussed by Major Moch are touched upon in the original article, the author of which is Capt. Fuldon.

NOTES AND NEWS.

Switzerland. Adverse criticisms, it would appear, are being directed by the German Swiss section of the military press to the provisions of the Swiss law, whereby the officers holding command of the higher units and the formations of the Army have been granted fixed annual emoluments on the same principle as the higher officials of the Federal Military Department. The writer of the original notes refers to Colonel Sarasin's article in the number of the *Revue* under notice (see *ante*); he evidently is not in agreement with the gallant Colonel's proposals in relation to the Landwehr being transformed into a depôt for feeding the active units, nor to the scheme for reducing the establishment of the troops of the Élite. The cutting down of the Vote for the Army has, it is stated, already resulted in the abandonment of the training of a part of the Landwehr during the current year.

Attention is called to a pamphlet by Monsieur P. O. Bessire, entitled *La question jurassienne*; the question of the alleged desire for separation on the part of the Jurassians is discussed therein. It would appear that the Jurassians are proud of their connection with the Canton of Berne and that the majority of them are by no means "separatists."

France. A special correspondent deals with the experiences of France during the great War: the War, he points out, enabled the French nation to discover what it was capable of in the fields of production, of courage, of tractability and of endurance. In view of all that France has gone through during the past five years, it is naturally with a tone of deep regret that he refers to the divisions and differences which now appear to exist in every quarter and every institution in France. His opinion is that it is not reorganisation that the French Army requires, but rather that it should be endowed with a "new soul." However, the reformers are not troubling themselves in the least with regard to the last mentioned aspect of the situation.

Now that the Censorship has come to an end, the question is being

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openly discussed as to whom shall be given credit for the " miraculous " victory on the Marne in September, 1914: reference is made to three works in which the claims of General Galliéni are favourably reviewed. These works are General Le Gros's *La Genése de la bataille de la Marne*, M. Victor Margueritte's *Au bord du gouffre* and General Percin's *Galliéni et Sarrail*. Other War questions which have been receiving a share of attention are those relating to the evacuation of Lille and the offensive of the 16th April, 1917; these questions are, it is pointed out, fully dealt with in General Percin's *Lille* and in an article entitled *La verité sur l'offensive du avril* 1917 published in a Special Number of the fortnightly review *La Renaissance*.

It is stated that in the early months of the late war General Gabriel Rouquerol prepared a series of *Notes and Criticisms* on the events of the time. He has now published his records under the title *Aprés la victoire*. The volume discloses the state of mind of those who were at the front; its author is silent with regard to those things that were well done, and confines his attention to those matters in which there was room for improvement.

Belgium. A special correspondent deals with the present day situation. The military and civil authorities of Belgium find that it is as difficult to resume conditions of peace after five years of a devastating war as it was suddenly to put on the garb of war after many decades of peace.

It is suggested that the task of first importance before the country is a re-organization of the Belgian Army; the military edifice built up during the progress of the recent conflict was not based upon any systematic plan, but on a succession of more or less lucky compromises. The time has now arrived to overhaul the structure, since it is in a frail condition owing to the wear and tear it has suffered. The failure of the authorities to revise the scales of pay of officers and N.C.O.s to meet the conditions arising from the rise in prices is leading to an exodus of officers and N.C.O.s from the Army who are being attracted into the fields of industry by the better remuneration and the brighter prospects offered therein.

The people of Belgium do not seem to be much enamoured with the idea of a League of Nations; there faith in ' solemn treaties ' has been much shaken by their recent experiences. For this reason, the Belgians feel that one of the most interesting problems for them to investigate is that of military alliances. The Belgian people ardently desire to have the terms of the Treaty of 1839 revised; it is evident that they are much disappointed with the provisions of the Treaty of Versailles so far as it affects their country. A defensive military federation from the Sea to the Alps is being advocated by quite a number of persons in Belgium.

Italy. A special correspondent points out that the great problem for consideration in Italy, in the year of grace 1920, is that of the organisation of the Italian Army. The recent elections have resulted in the socialist and the " popular " catholic groups winning 250 seats in the Lower Chamber: both these groups have programmes for reforms of an extremely bold kind, including a drastic reform of the Army.

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Although both groups desire to abolish the present organisation of the Army, on the other hand, they are not in agreement as to what shall take its place.

INFORMATION.

Brief notes are given under the above heading on the military press in Italy, France and Switzerland.

W. A. J. O'MEARA.

RIVISTA DI ARTIGLIERIA E GENIO.

September 1919.

THE ITALIAN EXPEDITIONARY FORCE IN MACEDONIA.

When the Italian contingent disembarked at Salonika in the beginning of August 1916, the inter-Allied army of Macedonia consisted of a few French and English divisions, two Russian brigades and the Serbian army, occupying a front of about 300 kilometres, extending from the Greco-Serbian frontier on the north-west of Lake Presba to the mouth of the Struma in the Gulf of Orfano.

To this army was entrusted the duty of covering the important base of Salonika and of barring the enemy's access to Greece ; the length of front in relation to the small disposable force constrained it to a purely defensive attitude.

The Italian contingent, consisting of the 35th Division, under the command of Lieut General Petitti di Roreto, disembarked on the 11th August. It comprised :—

The Sicilian Brigade (61st and 62nd Infantry Regiments).
The Cagliari Brigade (63rd and 64th Infantry Regiments).
Two machine-gun companies.
One squadron of cavalry.
Four groups (8 Batteries) of Mountain Artillery.
Four Companies of Sappers, one Company of Miners.
One Company of Pioneers, one Company of Telegraphists, with numerous and well-equipped divisional services.

On disembarkation it came under the command of General Serrail, Commander-in-Chief of the Allied Army of the East, and occupied the sector Krusa Balkan on the lake Butkova. The length of this line was over 40 kilometres, and its importance required no slight efforts and activity to ensure the safety of its lengthy defences.

In September the pressure of the enemy on the western portion of the front becoming more threatening, while an epidemic of malaria was reducing the efficiency of many units, General Serrail asked for an increase of the Italian contingent, and before long reinforcements including the Ivrea Brigade (161st and 162nd Infantry Regiments) and many small units arrived, which raised the numbers of the contingent to 50,000 men and 10,000 animals.

The expedition encountered considerable difficulties at Salonika, which was extremely crowded owing to the fact that it was the Naval

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base of five armies, but all obstacles were quickly overcome, services were at once systematised, and within three weeks from their disembarkation the troops were able to enter the lines on Krusa Balkan, at 80 km. from Salonika.

The sanitary service was organised with special care. Five hospitals were established and supplied with complete equipment including bacteriological cabinets and all necessary chemicals, etc., and giving accommodation for 4000 beds. The *personnel* included fifteen voluntary nurses.

There were also two convalescent depôts and a sanatorium for malarial cases in the healthy wooded locality of Niaussa. The base hospitals further provided civil ambulance services which rendered the greatest assistance in succouring the victims of the great fire which broke out in Salonika in August 1917.

The magazines at the base contained bakeries and repair workshops, and the Artillery and Engineers also had numerous workshops, in the last of which much important work was done in providing and repairing the machinery for the artesian wells. Water mains were laid for a distance of about 6 km.

The motor transport service was carried out under great difficulties caused by bad roads and unfavourable climatic conditions. A sensible improvement in transport took place in July 1917, when it became possible to run an Italian train daily towards the front with 10 locomotives and 150 wagons imported from Italy. The two principal lines of railway were from Salonika to Florina about 180 km., and from Florina to Erzek, about 135 km., the latter of which, traversing a mountainous district, had been constructed by the Allies.

The counter-offensive conducted by the French and the Serbians in September 1916 in the neighbourhood of Lake Ostrovo and Farina, removed the immediate threats against Greece and against Salonika. The Bulgarians were forced to retire 40 to 50 km., and abandoned Florina. They retired to Monastir leaving the Serbians in possession of Kaymachcalan. The Serbians made some progress on the east of the Cherna, in the Vetrenek district, while the Italians engaged the enemy at Krusa and the English repulsed the Bulgarians on the Vardar and Struma.

In October, owing to bad weather, the operations were limited to the actions conducted by the Serbians and French in the Western, or Cherna, section.

The offensive was resumed in November with the object of gaining possession of Monastir, a centre of great importance to the enemy. The principal attack was made by the Serbians, French, and Italians, who manœuvred in the Cherna valley with a view to occupying the town and the dominating positions around it. Meanwhile, on the front between the Cherna and the Vardar and in the neighbourhood of Lake Doiran the remaining Allied troops made an energetic demonstration against the enemy.

The Italian detachment which took part in the decisive attack consisted of the Cagliari brigade with a machine-gun company, two mountain batteries and squadron of cavalry. After a march of 200 km.

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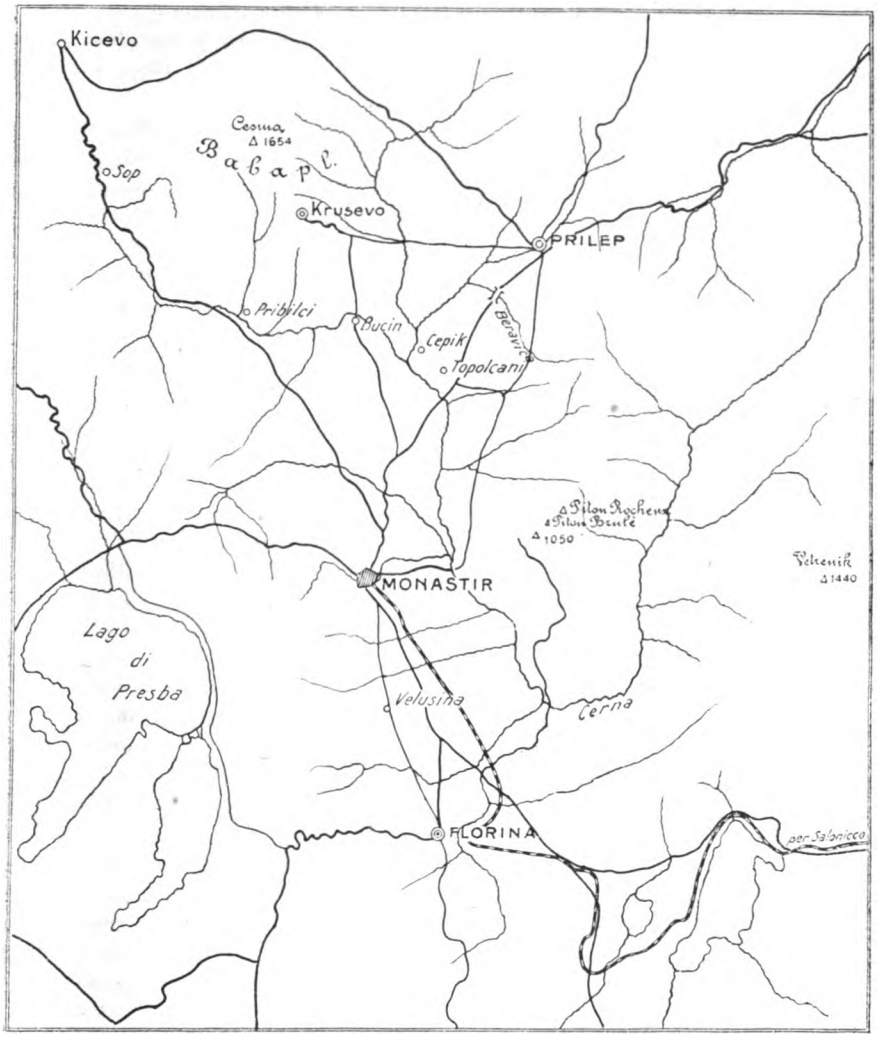

in the rain and through marshy and inundated country this detachment arrived at the steep mountain of Baba, on the north-west of Florina, and immediately became engaged in the tactical dispositions of the 57th French Division. On the 19th November it received orders to advance, with its left on Baba mountain and its right in touch with the French and Serbians in the Cherna Valley. The steep mountainous country, rising to 1000 and 2000 metres, was tenaciously held by the enemy and the tactical difficulties were augmented by violent and persistent snow-storms. On the 19th the right wing of the Cagliari Brigade, after a sharp action, occupied the Dente di Velusina, which combined with the successful action of the left wing, deprived the enemy of positions dominating the valley and facilitated the advance on Monastir.

The same evening troops of all three nationalities entered the

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Macedonian capital, and on the 21st and 22nd the heights on the west and north of the town were occupied, but the operations were stopped by the intense cold and driving snow. The sector allotted to the Italian contingent was that near point 1050 in the Cherna area.

While these operations were in progress the rest of the Italian troops fell back from Krusa Balkan on Florina, and towards the end of November the whole force was concentrated between Monastir and point 1050. The district was devoid of vegetation and the line, partly in marshy and malarious ground, partly in rocky mountains dominated by the enemy, was one of the most difficult of the front positions. The French and Serbians, in their advance after the capture of Monastir, had halted on the slopes of point 1050, Piton Brûlé and Piton Rocheux, on a line which should have been only provisional but which owing to the force of circumstances became permanent in spite of its many difficulties. These positions were of great importance to the Allies, and although the enemy concentrated against them all the Prussian battalions and their best artillery, the Italian troops did so well that the Commander-in-Chief was always opposed to their transfer to another section. Continuously bombarded and without any natural cover the Italians had to erect immense fortifications in the face of great difficulties and sacrifices. It is sufficient to say that they excavated 110 km. of trenches and communications of a depth of 1·1 to 2·0 metres, for the most part in rocky ground, and about 500 caves in the rocks, and they also put up 130 km. of barbed wire, with a depth of 5 to 6 metres.

To the losses inflicted by the enemy were added those caused by sickness, including the epidemics prevalent in Macedonia, fever, dysentery, typhus, etc. During four months of the autumn about 6000 sick were sent back to Salonika each month, half of whom had to be repatriated.

The troops lived for 21 months without any detriment to their warlike spirit from the discomforts and dangers of these conditions.

The sector of Point 1050 was considered so unsatisfactory that the Serbian supreme command suggested to the Italians that it should be abandoned, but the brave soldiers of the Italians held it against all attacks.

The information acquired by the Commander in Chief in Salonika during the summer of 1918 regarding the internal condition of Bulgaria, that it was weary of the war and despaired of success, led him to infer that a general offensive if vigorously pressed would have good results. The forces at his disposal numbered 100,000 rifles and 1600 guns while the Bulgarians and Germans had 200,000 rifles and 1300 guns.

The principal action of the Allies was conducted against the enemy's centre in the Vetrinik—Koziak district, between the Cherna and Vardar, with the object of penetrating deeply into his positions, and cutting off the right wing of the Bulgarians threatening their communications and opening the road to Prilep and Uskub. This action was allotted to the Serbian army reinforced by two French divisions. A secondary attack was to be made by British and Greek troops in the Vardar sector, while another action with a different object was to be made by Greeks in the Struma sector.

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In the Monastir sector the Italian troops with the French on their left had to advance in the direction Tapolcani—Prilep, as soon as the Serbians and French had succeeded in breaking the enemy's centre.

On the morning of the 15th September the 2nd Serbian army and the French divisions attacked the Vetrinek Sector and in a few hours succeeded in breaking the enemy's first line. At the same time the 1st Serbian army advanced on the left, converging to the west in order to turn their right towards the Cherna. The enemy continued to give way at the centre but held on at the flanks, compelling the attack to a battle lasting five days. On the 21st the Allies finally occupied the whole of the zone comprised between the eastern branch of the Cherna and the Vardar.

The tasks assigned to the Italian contingent were the following :—

1. In the days immediately preceding the Serbian attack to make a demonstration in the bend of the Cherna, so as to prevent the enemy from moving his reserves towards the Serbian sector ;

2. To assist the Serbian attack by intensifying the demonstration, and stoutly to resist the enemy's counter-attacks in the Cherna sector ;

3. On the success of the manœuvre, to join in the pursuit with Prilep as the objective, the principal base of hostile reinforcements. The difficulty of these tasks was intensified by the unfavourable conditions of the Italian positions, and the weakness of their heavy artillery, which was reduced to three batteries in order to increase the allotment in the Serbian sector.

The demonstration which lasted from the 13th to 21st September in the form of a heavy bombardment and incessant Infantry action was successful in pinning the enemy to his positions, so that he was unable to send his reserves to the Serbian Sector.

At 7.45 p.m. on the 21st, having received notification that the Serbian menace to the Prilep defences was increasing, the Italian commander General Mombelli led forward his troops to the attack. An hour later the enemy's first line was completely broken and although the nature of the ground favoured his retreat several hundreds of prisoners were taken. The pursuit was carried forward during the night, and by the morning of the 22nd the Italians had penetrated 10 km. into the enemy's territory. On the 23rd his last resistance on the heights of Tapolcani was overcome and on the following day the troops were in readiness for the attack on Prilep.

But at 2 p.m. on the 23rd orders were issued that the Prilep objective was to be left to the French divisions on the right, and that the Italians turning 90° to the west were to advance on Krushevo, crossing the difficult *massif* of Baba Planina, in order to cut off the enemy from the Monastir region.

This arduous operation was commenced forthwith in spite of the fatigue of the troops, and was continued on the 24th. On the 25th the Italian right wing gained the ground at the foot of the mountains, but the centre was held up by the enemy's resistance at Krushevo. On the 26th this resistance was completely overcome, the right wing pressed forward under the Chesma mountain, the centre occupied Krushevo, and the left commenced an attack on Pribilci, where the enemy's retreat

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from Monastir towards Sop had been arrested. The same evening a strong column pushed forward from Krushevo.

On the 27th the right wing overcame the difficulties of the ground on the higher slopes of Baba Planina and threatened the enemy's positions on the east and south-west of Kicevo. On the 28th the Italians advanced to the neighbourhood of Sop. On the 29th the right wing and centre carried out an encircling movement, while the left wing attacked on the south. The enemy, it is now known, had received reinforcements, including numerous machine-guns, during the night. The Italians encountered strong resistance and had to recognise in the Bulgarian commander a stout adversary.

The attack was renewed on the 30th and the situation favoured a success, when at 5.0 p.m. the order was given to suspend hostilities.

On that day the following numbers of prisoners were in the hands of the Italians:—A General commanding a division, two brigade commanders, 240 officers, 7627 soldiers, with 7000 rifles, 70 machine-guns, several heavy and light field guns, and a quantity of war material.

Bulgaria having been forced to capitulate the Allied army of the East carried forward its victorious offensive towards the Danube and Constantinople. The Serbian army reinforced by French and Greek troops was directed towards Nish and Belgrade. Some English and French divisions, reinforced by a third of the Italian contingent prepared to operate against Turkey, and the remainder of the English, French, and Italian forces traversed Bulgaria and marched towards Roumania, where it appeared that the German army of Marshal Mackensen had the intention of offering resistance. Turkey however soon capitulated, and Mackensen's army, owing to the collapse of the Austro-German resistance in Europe, was obliged to surrender. Only the French and Serbians, operating in Old Serbia in the occupation of Belgrade, met with any resistance.

The general cessation of hostilities arrested the advance and gave repose to the valiant contingent which in 27 months of hard fighting, arduous fatigues and privations, and sufferings of every kind, had gloriously upheld its country's flag, and emulated by its valour its brother combatants on the Italian front and in Albania.

The conduct of the men, severely tried for so long a period, their discipline and courage, established between them and their allies a true brothership of arms, and merited the repeated eulogies of the Commander in Chief.

The Italian losses in Macedonia numbered 2841 killed and 5353 wounded. The severe conditions of service undergone by the troops are confirmed by the fact that, between April 1916 and December 1918, about 80,000 men had been under treatment in hospital.

E. T. THACKERAY.

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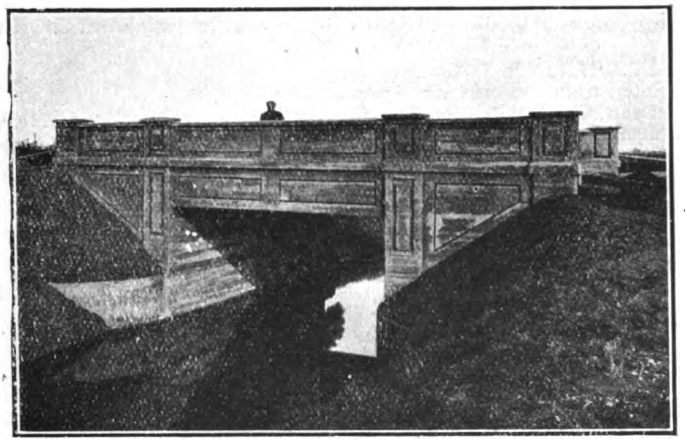

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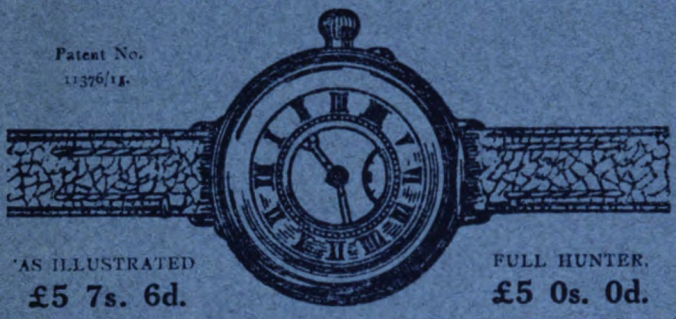

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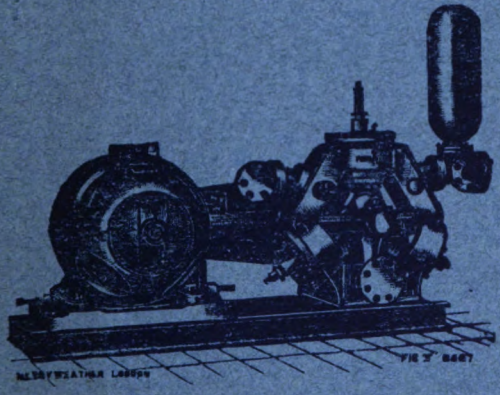

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Vol. XXXI. No. 4. APRIL, 1920.

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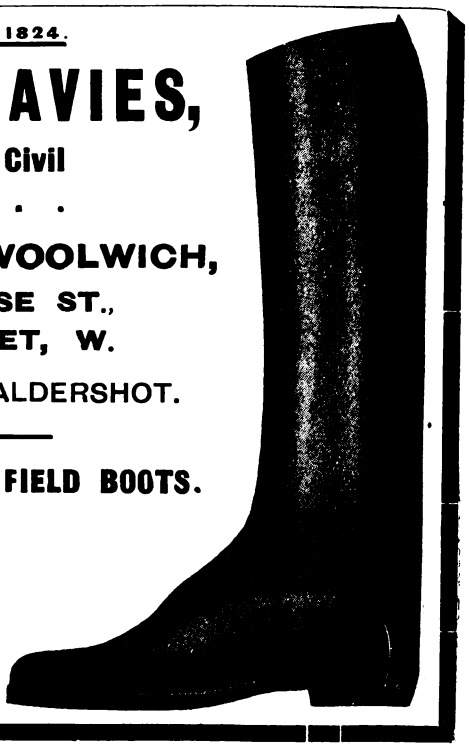

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(*a*). Descriptions of works actually carried out in peace or war.
(*b*). Inventions.
(*c*). Design (excluding works of defence).
(*d*). Labour organization on work.
(*e*). Scientific investigations generally.
(*f*). Accounts of exploration work and surveys.

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THE EFFECT OF TANKS ON PERMANENT FORTIFICATION.

By Bt. Major M. F. Grove White, D.S.O., O.B.E., R.E.

It is realized that in the following notes opinions are expressed which are controversial. It is not desired to insist on the correctness of these views. It is desired, however, to open up discussion on a subject to which insufficient attention has been paid, viz., the effect of tanks on the future development of fortification.

A good many articles have appeared from time to time in the *R.E. Journal* dealing with the future of Permanent Fortification. The general trend of these articles is that this type of work will merge into Field Fortification, but that development of communications and measures for Anti-Aircraft defence will be the chief factors in the organization of a frontier for war.

In this article it is desired to examine the probable effect of tanks on permanent fortification at the commencement of a war. To do this it is necessary to examine the conditions which are likely to exist. By permanent fortification is implied work of such magnitude or scope that it will usually be carried out in peace time as a preparation for war.

When war is declared between two nations, such as France and Germany, the Frontier Corps, which in peace time are much more nearly on a war footing than the corps in the interior, at once deploy, facing each other on the frontier. The rôle assigned to these corps is to gain time for the assembly, concentration, and subsequent deployment of the main armies behind them. Hitherto, they have been supported by the great frontier fortresses, e.g., Verdun, Toul, Epinal, Belfort. These fortresses form pivots for the defence and so facilitate the gaining of time by the Frontier Corps in case of attack. Speaking generally, the rôle of these corps on both sides will be defensive.

Unless one side adopts a purely passive defence,—a hopeless proceeding,—each side will endeavour to gain the initiative by attacking first. The side which can mobilize and concentrate first will usually be in a position to seize the initiative.

Mobilization will probably be worked up in peace time to the highest pitch of perfection and, therefore, once war is declared, an

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army should first prevent interference with its own mobilization and then, if it can, hinder the enemy's. But between it and the enemy's mobilization areas lie the enemy's Frontier Corps, and, by virtue of the great defensive power conferred on troops by modern fire-arms, these corps up to the present have been usually strong enough to stave off any attacks which can be made with the troops available before mobilization is complete.

As soon as one side is ready it will attack. The other side will endeavour to delay the hostile advance and so gain time to effect a redistribution of troops with which to stop the attack and subsequently, by launching a counter-offensive or otherwise, to regain the initiative. If this time cannot be gained defeat will probably result, always assuming of course that the attacker's plan is good and that he makes no mistakes. Therefore the object of the attacker is to sweep away the initial opposition quickly, the defender's to gain time. Here again the defender will rely on the defensive power of modern fire-arms.

It follows then, that in a war on a continental scale all armies will almost certainly at some time or other be forced to interpose a barrier between their main forces and the enemy, so that they may gain time to allow their plans to take effect. This barrier has been the fire power of relatively small bodies of troops and these troops have used fortification to increase their defensive power. Up to the present General Langlois, quoted by a writer in the *R.E. Journal* recently, was justified in saying that the strength of resistance lies in invisibility and in the extension of numerous and relatively feeble obstacles.

But lately there has appeared an instrument of war, the tank, to which numerous and relatively feeble obstacles are no obstacles at all, and which can pass unharmed through belts of fire which would be impassable to infantry. The chief feature of this weapon is its offensive power and the enormous assistance which it gives to an attacker in sweeping away opposition.

We may expect the tank of the future to possess the following qualities :—

(*a*) Power of manœuvring at night and in smoke or gas clouds.
(*b*) Great speed, 30 miles an hour or more.
(*c*) At least as great power of crossing obstacles as at present.
(*d*) Power of striking at a point at least 150 miles from its base and returning.
(*e*) Power of floating and crossing rivers or water self-propelled.
(*f*) Power of climbing slopes of 1/1 at least.

The power of artillery to deal with such tanks will be very much limited by (*a*) and (*b*) above. This also applies to aircraft, anti-tank rifles, anti-tank machine guns, rifle grenades, and similar weapons.

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The effect of (*c*), (*e*) and (*f*) will be that practically no natural obstacles will stop a tank except large marshes, thick woods and precipitous mountain ranges ; (*b*) and (*d*) will give the tank the power of striking at vital points behind the enemy's lines.

It is obvious that troops deployed behind numerous and feeble obstacles cannot hope to deal with fleets of tanks of this nature and, in consequence, each army will try to make tank raids through the opposing lines with the object of delaying the hostile mobilization and concentration.

Fleets of tanks also will come into action with the main attack and, by sweeping away opposition quickly, will prevent the enemy from taking counter-measures in time. In fact, the obstacle of fire-power, as we understand it at present, will cease to exist, and it will be necessary to find some other obstacles capable of holding up tanks.

A water obstacle will be of little value ; tanks will be able to bridge it or float across it very easily. A vertical wall or better still a broad ditch with vertical sides would stop a tank or at any rate delay it considerably. Of course, it would be possible to detroy such an obstacle by mining or bombardment, but such a measure would entail delay and enable the defenders to concentrate guns and tanks at the threatened point.

Afforestation of a frontier might be of value.

Mine fields may be used. These mines might be electrically controlled. Even contact mines might be used successfully. Any attempt to clear a passage by pushing a roller in front of a tank is not likely to be successful, as a fuze can easily be designed which will act only under sustained pressure. If anything like an empty tank is pushed over a mine field its wreck will block the path to following tanks almost as effectively as a mine. Probably a combination of wall and mine field will be most effective. Such an obstacle will be necessary along the vital portions of a frontier and probably round all important centres of communication and all strategically important points within 200 miles of the frontier or more.

It is pointed out that all this does not affect the principles of war. In the past when infantry was the main attacking arm we opposed to infantry the obstacle of fire power and barbed wire. Now that tanks are likely to become the main attacking arm, we must still oppose an obstacle, but a material obstacle, to enable us to concentrate tanks to hold up and counter-attack the opposing tanks while the mechanical resources of the country are being mobilized.

But these new obstacles, ditches, walls, and minefields, must be constructed largely in peace time and are, therefore, permanent fortifications.

The idea of a long barrier wall is really not fantastic, as witness the Roman wall in North Britain and the Great Chinese wall. In any

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case it seems possible that the expense of such an obstacle would be less than the expense of the alternative, the permanent presence of enormous masses of tanks and anti-tank weapons on the frontier.

Now to consider how the tank of the future may affect the British Isles.

It is not extravagant to suppose that in the future we shall find ourselves threatened with tank carrying ships, possibly submersible, which will approach our coasts and disgorge fleets of tanks capable of floating and self propelling in the water. The landings will be carried out at night or under cover of smoke and will be aimed at our naval bases, ports, railway junctions near the coast, etc. It appears as though we should have to provide points of this nature with anti-tank fortification. At any rate, the possibility is worth considering.

The tank which has been discussed in this article is the cross country fighting machine. There will also be, however, cross country tractors for the carriage of stores, infantry, guns, etc. These also will add to the rapid offensive power of an army. Any obstacle which will stop these tractors or even confine them to a few defiles will add enormously to the power of defence by delaying the attack.

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THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914—1919.

BRIDGING.

APPENDIX.

Formation of R.E. Bridging School.

1. The introduction into the British Army in 1915 of steel bridge spans, composed of sections of light weight for transport facilities, was an innovation which necessitated the training of Officers, N.C.O.'s and men of the Royal Engineers in their use and erection.

All bridge spans were originally landed at Havre, and it was decided to form classes of instruction in the erection of these bridges there, under the R.E. Stores Officer.

Eight courses were arranged at Havre and 86 officers and 281 N.C.O.'s and men were given practical instruction in the erection of steel spans, and timber piers and abutments.

It was found, however, that this arrangement was unsatisfactory since it entailed much extra work for the Staff of the R.E. Base Park, and the classes could not be held as frequently as was necessary to train a sufficient *personnel* to deal with the large amount of Bridging which obviously might at any time become an urgent service.

It was therefore decided in 1916 to establish a School of Instruction in Bridging in an Army Area, and to hold classes regularly during the Winter months.

Choice of Site.—Accommodation.

2. The considerations which governed the choice of a suitable site were :—

(i.) The school should be near a convenient rail centre, so as to facilitate transport of bridging material, and of the *personnel* of the classes.

(ii.) It should be near the canal system of the Armies.

(iii.) A suitable stretch of river, some 200 yards in length and about 60 feet wide, was required, with sufficient ground adjacent to it on which to build the spans and launch them.

(iv.) The river should be 6 to 8 feet deep, and have a fair current in order to give facilities for the erection of piers, etc., under the conditions usually met with in the Field.

(v.) Sufficient accommodation should be available near the site for the Staff of the school, and the *personnel* of the classes.

(vi.) There should be good facilities for entrance and exit of transport conveying bridging material.

In October, 1916, several sites were visited and reported upon by the newly appointed Commandant, and it was finally decided to establish the School at Aire on a by-pass of the River Lys.

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The ground available was low-lying, but there existed a good stretch of water on which there was no canal traffic.

The site was excellent for the erection of bridges, though the transport facilities were not good, but the latter was not a matter of great importance at the time, since the quantity of material to be kept at the School was small.

Accommodation.—Accommodation for the Staff was arranged in billets in the town, and the *personnel* of the classes was accommodated in barrack barges on the river.

Barge bridging Depôts had been formed in 1915, and some of the barges so used were converted for use as barrack barges, the stores and bridge spans which they contained being unloaded and used at the school.

In October, 1917, a hutted camp was built at the site of the school for the accommodation of the Staff. This was much more satisfactory than billets in the town.

Dining Hut.—In November, 1917, the efficiency of the school was greatly increased by the addition to the accommodation of a large hut 90 ft. by 30 ft. This was used as a lecture room for N.C.O.'s and men, and as a dining hut. It was erected near the existing cook houses so that meals were better served than in the barges.

This hut also enabled better instruction to be given to N.C.O.'s and men; diagrams of bridges were exhibited in it, and men could work there in their squads at schemes and exercises, and be visited by the Assistant Instructors.

Owing to the difficulty experienced in working on sodden ground during the winter of 1916–17 the bridging ground was, in October, 1917, covered with a layer of six inches of shingle. This greatly improved the site, and the men had always a dry ground to work upon even in bad weather.

Removal to new site.—The school was situated at Aire during the winters of 1916/17 and 1917/18.

Early in 1918, owing to the great increase in the amount of material which it became necessary to stock at the school in order to give instruction in all branches of the subject, it was found that the limited facilities for transport and handling of material at Aire were a serious disadvantage, and in April, 1918, the German advance made it imperative to evacuate all bridging stores from Aire. It was therefore, not considered advisable to re-establish the School there, and in August, 1918, a fresh site was selected.

Site at Monchy Cayeux.—The Communal ground at Monchy Cayeux on the River Ternoise was chosen. This site was eminently suitable for the work required. There was a large area of ground available with good soil for anchorages, etc., and plenty of room for the erection of large spans.

The river itself was only 22 ft. wide and 2 ft. 6 in. deep, but the width between banks, which were 5 ft. to 7 ft. high, varied between 70 and 100 feet.

In order, therefore, to provide a sufficiently large water gap, a timber dam was constructed below the bridging ground and the level of the water raised by 4 feet.

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The design of the dam is shown in *Plate* XXXII. The construction of it provided useful experience for the first class at the School in October, 1918.

This gave a water gap of 60 feet with sufficient depth to float pontoons.

Camp.—A suitable field existed for a hutted camp.

The *personnel* of the Staff and of the Classes was therefore accommodated in huts, which were found much more satisfactory than the barges at Aire.

A plan of the R.E. Bridging School as it existed at Monchy Cayeux is given on *Plate* XXXIII.

Sports.—The surrounding country at Monchy Cayeux provided better facilities for games than existed at Aire, and a football ground, tennis courts, and a golf course were constructed.

DEVELOPMENT OF STAFF OF THE SCHOOL. WAR ESTABLISHMENT.

3. (*a*) *Original Staff.*—The Instructional Staff at the opening Classes consisted of :—

Commandant and Chief Instructor	1
Instructors	2
Adjutant and Assistant Instructor	1
N.C.O. Assistant Instructors	3
Clerk	1
"B" *Personnel* for Camp Duties	12

(*b*) *First Increase.*—As the courses developed and the number and variety of steel spans increased, this staff was found insufficient to give all the instruction necessary to fully cover the ground, and an increase was made.

The Establishment authorised under War Establishment No. 652 dated 15/8/17, was as under :—

Detail.	Personnel. Officers	Warrant Officers.	Staff Sjts. and Sjts.	Rank and File.	Total.	Remarks.
Commandant and Chief Instructor. (*a*)	1	...	...	...	1	(*a*) Major R.E.
Instructors. (*b*)	2	...	...	...	2	(*b*) 1 Capt. R.E.
Adjutant	1	...	...	...	1	
Coy. Serjt. Major	...	1	...	...	1	
Coy. Qr.Mr. Serjt....	...	...	1	...	1	
Assistant Instructors	...	...	3	...	3	(*c*) "B" *personnel.*
Storekeeper	...	...	...	1	1	
Clerk	...	...	...	1	1	
General Duties (*c*) ...	...	...	...	22	22	
Total ...	4	1	4	24	33	

(*c*) *Second and Final Increase.*—This Staff was sufficient to deal with the work done during the Winter of 1917–18, but in October, 1917, the number of different types of bridges had doubled, and there were no less than 24 different types in which detailed instruction had to be given, in addition to steel cube piers, piles, trestles and other bridging expedients.

In addition to the practical work, it was realised that very much more detailed instruction was required in Reconnaissance, Organisation, and Design.

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Schemes (as set forth in another paragraph) had to be given to Officers and their solutions fully discussed with them.

The necessity of ensuring a high standard of efficiency at the school was realised as a result of the bridging work carried out during the autumn of 1917.

Application was therefore made for an increase in the Establishment, which was authorised under War Office letter 121/France/1407 dated 16/12/17.

The War Establishment of the R.E. Bridging School, France, as authorised under War Establishments Part VII A. No. 990, is :—

Detail.	Personnel. Officers.	Warrant Officers.	Staff Sjts. & Sjts.	Rank & File.	Total.	Motor Cycles.	Bicycles.	Remarks.
Commandant and Chief Instructor (*a*).	1	...	...	...	1	...	...	(*a*) Major R.E. or Lt. Col.
Instructors. (*b*) ...	3	...	...	...	3	(*c*) 1	(*d*) 11	(*b*) Capts. R.E.
Adjutant	1	...	...	...	1	...	...	(*c*) with side car.
Senior Assistant Instructor. (*e*) ...	...	1	...	...	1	...	...	(*d*) for students
Coy. Serjt. Major ...	...	1	...	...	1	...	...	(*e*) W.O.Cl. 1.
Coy. Qr.Mr. Serjt. ...	...	...	1	...	1	...	...	(*f*) Includes 1 Cpl. and 2 Sappers
Assistant Instructors	...	...	6	...	6	...	...	
Corporal	...	...	...	1	1	...	...	
Storekeepers ...	...	...	...	(*f*) 3	3	...	...	(*g*) Sapper.
Clerks	...	...	...	(*f*) 3	3	...	...	(*h*) Includes Lce.Cpl.
Draughtsman (Mech.)	...	...	...	(*g*) 1	1	...	...	
Privates. (*j*) ...	...	...	...	(*h*) 33	33	...	...	(*j*) " B " *Personnel*
Batmen. (*j*) ...	...	...	...	5	5	...	...	
Total ...	5	2	7	46	60	1	11	

Supersedes W.E. No. 652.

War Office, (S.D.2.).
15th February, 1918.

The rank of Lieutenant Colonel was approved for the Commandant of the R.E. Bridging School under War Office letter 121/France/2578 (S.D.4) dated 13/8/18.

COMPOSITION AND DURATION OF CLASSES.

5. When the School opened at Aire in December, 1916, each class consisted of 20 Officers and 100 N.C.O.'s and men. This figure was found the most suitable for working and was not altered subsequently.

Usually one-third of the *personnel* was drawn from Field Companies in the B.E.F., and the remainder from Army Troops and Tunnelling Companies R.E., Officer students included Field Engineers and representatives from the D.G.T.'s Branch. During 1916/17 the duration of each course was 10 working days.

As the work developed and increased it was found that in a course of 13 days the instruction had to be so concentrated, and there was so much to be got through, that it was thought advisable to further extend the course to 20 working days. This course was much more satisfactory, and was adopted in 1918. It gave the students more time to assimilate the lectures, and more time to devote to their schemes and exercises.

Special Course.—Early in 1917 after six ordinary courses had been completed, it was thought that a nucleus of specially trained Officers and N.C.O.'s should be available in each Army for bridging work.

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It was therefore decided to hold, in March 1917, a special long course of one month, the class consisting of promising students of the previous courses, and officers who, in the appointments they held, would probably be called upon to do bridging work.

This course was composed of 12 Officers and 36 N.C.O.'s, and was held concurrently with Classes Nos. 7 and 8, which were of the usual size.

The special training included advanced instruction in design, erection and handling of the various types of spans.

Organisation of Classes.

6. For administrative purposes and for practical work the classes were divided into 10 squads of 10 men each. The ten squads were organised into five groups of 2 squads each.

A Serjeant Instructor was put in charge of each group, and was responsible under the Senior Assistant Instructor for the instruction of the group.

The Senior N.C.O. of each squad acted as squad leader during the course; his duties were to organise the work of his squad, especially the indoor work in the execution of schemes and exercises, and to arrange discussions of the various problems among the members of the squad.

The Assistant Instructors of each squad attended these discussions to answer questions and explain difficulties.

The N.C.O.'s of each squad were detailed as squad commanders in practical work in rotation, so that each N.C.O. would get practical experience in organising a small squad of men on bridging work.

An Officer Instructor was in charge of all practical work, and prepared the design of the bridges erected and programme of work, which was explained to all ranks before commencing.

The working hours were from 8 a.m. to 12 noon, and from 1 p.m. to 4 p.m. Lectures to N.C.O.'s and men were delivered during these hours; these lectures were generally of half an hour duration, and the remainder of the day was devoted to practical work on the ground.

For practical work officer students were put in charge of a group of two squads daily on the work, each officer being on group duty for three days consecutively, so that he could, as far as possible, carry out each scheme from the beginning till completion. These officers were required to take charge of the parties on the work, and to superintend N.C.O.'s and men of the class under the supervision of the officer in charge of practical work.

For indoor work on schemes and for reconnaissance work, the Officers' Class was organised in syndicates of two officers; one solution being called for from each syndicate.

Syllabus of Course of Instruction.

7. As the number of steel bridges increased, so the syllabus of instruction at the school expanded.

New types of bridges were designed and ordered from England, and new methods of erection devised.

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By February, 1918, however, samples of all the new types of bridges had been delivered at the school and erected, so that it was necessary subsequently to amend the syllabus.

The course was divided into :—

(i.) Practical Work.
(ii.) Lectures, indoor work, and Reconnaissance.

(i.) The practical work consisted of the erection of spans, construction of trestle and cube piers, pile-driving heavy and light, launching of heavy girders, use of derricks, tackles, pontoon rafts for pile-driving, etc., and in short, all operations likely to be required for bridging work in the Field were practised.

(ii.) *Lectures, etc.*—There were 20 lectures delivered to officers of each class.

These included a complete course of 8 lectures embracing organisation of bridging work, description of type spans, supply of materials and transport, bridging dumps, etc. ; three lectures in reconnaissance including aerial reconnaissance, three lectures on piles and abutments, three lectures on tackles, anchorages and launching, one lecture on simple applied mechanics, and two lectures on special types of bridges.

In addition to these lectures officers were shown on the ground the details of the various spans, one type being taken at each lecture which lasted 20 minutes.

There were four exercises and two schemes issued to each Class.

The exercises were simple applications of the principles taught in Lectures and practical work, and included designs for a pile pier, a trestle pier, a short span bridge and tackles required for launching main girders of stock spans.

The first scheme embraced the reconnaissance of an existing bridge with a view to determining what loads the bridge would take.

There were 12 lectures delivered to N.C.O.'s and men of each class.

These were of a practical nature, and included the description of such practical details of the work as N.C.O.'s and men would require in the field.

There were three schemes issued to N.C.O.'s and men.

One solution was required from each squad, the members of which worked together and discussed the problem among themselves.

The scheme included taking sections of gaps, an easy reconnaissance scheme for the reconstruction of a short span bridge, and an exercise in the organisation of working parties on bridge erection.

A typical programme of a course at the School is attached. (Schedule A.)

LIBRARY.

8. In order to encourage study of the various branches of bridge engineering a library was formed at the school in October, 1917.

Standard books of reference on bridge engineering were obtained, and issued to officers of the classes.

On arrival all officers were issued with a copy of the " Memorandum

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on Road Bridges," pamphlets on the Inglis and Hopkins Bridges and "Portable Road Bridges."

The squad leader of each squad of N.C.O.'s and men was also issued with a copy of these publications.

Material.

9. In order to make practical work as complete as possible, it was necessary to have in stock at the School, at least one span of each type in use with the Army.

The following is a list of the stock spans normally held at the school during 1918, which were erected and launched during the courses.

120 ft. Type Hopkins Bridge, 120 ft. Span.	1.
75 ft. Hopkins (Type) 90 ft. Span.	1.
85 ft. Class A. Span.	1.
60 ft. Mark II. Span.	1.
60 ft. Class A. Span.	2.
30 ft. Class A. Span.	1.
30 ft. Reinforced Span.	1.
21 ft. 6 in. Portal Lifting Bridge.	1.
21 ft. 6 in. Davit Lifting Bridge.	1.
21 ft. 6 in. Pont Levis Lifting Bridge.	1.
21 ft. 6 in. Class A. Span.	1.
21 ft. 6 in. Mark II. Span.	3.
16 ft. Mark II. Span.	1.
16 ft. Class A. Span.	1.
Inglis Rectangular Bridge, 72 ft. Span.	1.
Inglis Medium Type.	1.
Inglis Light Type (Twin Bridge).	1.
Sankey Pontoon Bridge (84 ft. length).	1.
20 ft. R. S. J. Field Bridge for Tanks.	1.
18 ft. R.S.J. Field Bridge for Tanks.	1.
20 ft. R.S.J. Field Bridge for 12 T. axle	1.
60 ft. Class B. Bridge	1.
30 ft. Class B. Bridge.	4.
13 ft. Class B. Bridge.	1.

In addition to the above material, the stores for an Army Bridging Depôt were kept in stock; these stores provided sufficient launching gear for use of the Classes, and a large stock of timber for piers, etc., was also held.

Examination and Reports.

10. For the classes held during the winter of 1917/18 and in the autumn of 1918, a report on each officer, N.C.O. and man was made at the end of each course.

Officers were marked for their ability in practical work as group officers, and a verbal examination was carried out by the Commandant at the end of each course.

All exercises and schemes were marked and a percentage mark was arrived at for each officer in practical work, design, reconnaissance and organisation.

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Officers were graded as to their capabilities for bridging work in accordance with the following standard :—

General qualifications for employment on Bridging Work.	Practical.	Design.	Reconnaissance.	Organisation.
	Per cent.	Per cent.	Per cent.	Per cent.
Specially Recommended ...	80	80	80	80
Recommended	70	70	70	70
Recommended for a Subordinate position, on Bridging work	60	50	60	60

Any officer not obtaining the qualifying minimum of marks in any subject as above was reported as " Not recommended for employment on Bridging Operations."

In the case of N.C.O.'s and men, marks for practical work were allotted by the Assistant Instructor in charge of practical work and the Commandant.

All N.C.O.'s when acting as squad commanders, were inspected and marked by the Commandant on their ability to command.

Marks for organisation and reconnaissances were given by the Commandant in a verbal examination held at the end of the class.

This verbal examination included questions on practical work given with a view to testing the man's powers of observation and the organising of parties, and, in general, on the students' knowledge of the work done during the course.

The following minimum marks were required for the qualifications stated :—

Qualifications for Bridging Work.	Practical. N.C.O's. and Sappers.	Organisation and Reconnaissance. N.C.O's.	Sappers.
	Per cent.	Per cent.	Per cent.
Very superior	90	80	75
Superior	80	70	60
Skilled	50	50	40
Not Recommended	under 50	under 50	under 40

COMPETITION BETWEEN SQUADS.

11. In each class a spirit of competition was engendered among all ranks.

Squads were marked collectively for the work done during the course.

The squad marks were calculated by averaging the marks obtained by N.C.O.'s and men of the squad in practical and oral work, and adding the marks obtained by the squad in the schemes carried out by them, as described above.

The marks of the best squad of the class were published in School Orders on the last day of the Class.

The names of the best serjeant, best corporal and the best sapper of the class, and marks obtained, were read out on the last parade of the course, and they were congratulated by the Commandant.

Their names were published in orders, and also the marks obtained by each N.C.O. and man of the Class.

RECORDS OF *PERSONNEL* TRAINED IN BRIDGING.

12. A record was kept on a card index system of all officers passing through the school, giving the marks obtained in each subject and the Commandant's recommendation.

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From the index to these cards it could be seen at a glance the number of officers trained in each Army and in each Unit. A similar card was kept for each N.C.O. and man.

These cards were kept " by units," so that it could be seen how many men had been trained in each Unit.

The index gave a cross reference for each N.C.O. and man by means of a serial number, so that any N.C.O. or man who had attended the school could be traced.

Numbers Trained.

13. 1916/17.—During the winter of 1916/17 the number of—

(*a*) officers, N.C.O.'s and men trained at the School were :—

Officers	150
N.C.O.'s and Men	806

The average number trained in each Army was 29 officers and 160 other ranks.

(*b*) 1917/18.—In 1917/18 the number trained were :—

Officers	166
N.C.O.'s and Men	861

The qualifications obtained by the officers were :—

Specially recommended for Bridging Work	20
Recommended	46
Recommended for a Subordinate Position	60
Not recommended	40
Total	166

The qualifications obtained by N.C.O.'s and men were :—

Very Superior for Bridging Work	48
Superior	169
Skilled	593
Not recommended	51
Total	861

The distribution of this *personnel* among Units was as follows :—

Field Companies	64 Officers and 269 Other Ranks.
Army Troops Companies ..	53 Officers and 407 Other Ranks.
Tunnelling Companies ..	28 Officers and 88 Other Ranks.
Other Units such as Cavalry Corps, H.Q.'s of Formation, D.G.T. etc. ..	21 Officers and 97 Other Ranks.

There were 156 Field Companies represented, 60 Army Troops Companies, and 28 Tunnelling Companies.

Taking the Session 1917/18 as typical of the distribution of students between Units, it will be seen that the average number of all ranks trained in each Field Company was two, in each Army Troops Company eight, and in each Tunnelling Company four.

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The training of such a small number of other ranks in Field Companies would not have much effect, but for a Field Company Commander to possess an officer trained in heavy bridging is valuable.

It is to be noted also that many Army Troops Companies sent a large proportion of their men to the school, especially those units which more or less became specialists in bridge erection.

(*c*) 1918.—During the autumn of 1918, before the cessation of hostilities the following numbers of officers and men were trained at the school :—

Officers	33
N.C.O.'s and Men	173

The qualifications obtained in the case of the officers were :—

Specially recommended	4
Recommended	15
Recommended for a subordinate position	12
Not recommended	2
Total	33

The qualifications obtained by N.C.O.'s and men were :—

Very Superior	17
Superior	42
Skilled	114
Total	173

(*d*) *Total Trained.*—Including the courses at Havre, it will be seen that the total number trained in heavy bridging from 1915 to 1918 was 435 officers and 2,121 other ranks.

In addition to these numbers, which were trained in the regular courses, there were held at the bridging school both during the summer of 1917 and the summer of 1918 short courses for officers and men in special bridging work in preparation for operations.

Approximately 20 officers and 250 other ranks received instruction of this nature.

REMARKS ON STANDARD OF WORK AND RESULTS OBTAINED.

14. (*a*) *Officers.*—Officers attending the courses were expected to have had some knowledge of the general principles of bridging as laid down in Military Engineering Part III., Sections III., IV. and V.

The general standard of Engineering knowledge of officer students was, however, not as high as it might have been, but nevertheless they took a keen interest in the work, and learnt a good deal about bridging during the short course which they had.

It was invariably noticed that those who were backward at the beginning improved considerably towards the end of the course.

Design and organisation were the chief stumbling blocks, since the majority of students were young Officers.

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The percentage qualifications of the best Officers' Class was :—

Specially Recommended	16%
Recommended	48%
Recommended for a Subordinate position	32%
Not recommended	4%

The large number of students of the school who were employed on Bridging work during the advance in the Autumn of 1918, and the success of those Bridging operations are sufficient justification for the existence of the School, and the results of the instruction thereat.

(*b*) *N.C.O.'s and Men.*—The standard of work shown by N.C.O.'s and men was excellent, and above the expectations of the Instructional Staff at the School.

The men were all very keen on the work, and greatly appreciated and benefited by the individual instruction which it was possible to give with the additional staff provided in November, 1917.

The answers given by N.C.O.'s and men in their verbal examination by the Commandant showed that they had worked hard during the courses, and had exercised their powers of observation to a remarkable degree.

The general inference to be drawn from this result is that the secret of training in bridge work is to provide a sufficient staff of capable instructors to give considerable individual attention to all students at the school.

Research and Experimental Work.

15. Careful records were kept at the school of the practical work done, and of the man-hours taken to erect the various types of spans.

These results were incorporated in the revised edition of "Memorandum of Road Bridges" written by the Staff of the School, and published in 1918.

New methods of erection were devised and experimented with, and new appliances for use with the various spans and for pile-driving were tested, and improved upon until they were suitable for use in the Field.

The results of these experiments were incorporated in the text book mentioned above.

Visits of Officers of Allied Armies.

16. In 1917/18 short visits of French and American officers were arranged at the school.

The work in progress was explained to them, and lectures were delivered in their own language.

Notes were also issued giving a description of the various bridges and the conditions governing their use in the Field, and details of the practical work carried out each day.

Reconnaissance of Existing Bridges in Army Areas.

17. In the execution of the schemes set them officer students made a reconnaissance of many bridges in the neighbourhood of the school.

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The results of these were tabulated, and further reconnaissance work was done by the Staff at the close of the courses.

The loads which these bridges would take were then calculated and tabulated, and the results distributed to the formations in whose area the bridges were situated.

These notes were found to be of great value in subsequent operations, notably during the German advance on the Lys in April, 1918.

During the Summer of 1918, some of the Staff of the School were employed on a reconnaissance of all bridges in the area occupied by the British Army. The load for each bridge was calculated and the results published.

ERECTION OF BRIDGES IN THE ARMY AREA BY THE CLASSES.

18. In connection with the preparation of the defensive line in the Lys area in February and March, 1918, it was required to considerably improve the road communications in the Army area.

Some of the new bridges required were within reasonable distance of the school, and as the work of the erection of these spans was of a very suitable description for instructional purposes, it was decided to erect them with the classes at the school.

No. 8 Class erected two Lifting Bridges over the River Lys south of Armentières.

The general type was a Pont Levis bridge supported upon pile piers in the centre of the river, and short spans on pile abutments on either side.

It was arranged for the piles to be driven by the Inland Water Transport who had near the sites suitable plant for the purpose.

Another bridge of a similar type, but with only one pile bent at each abutment, was erected at Merville over the River Lys.

Time for Erection.—In the case of the two bridges south of Armentières the spans for each bridge were erected in three working days of 8 hours each by the N.C.O.'s and men of the classes, under the supervision of the Staff of the School assisted by the group officers of the class.

The spans of the Merville bridge were erected in two working days.

These times were believed to constitute a record for bridges of this type, and demonstrate that with good organisation, steel bridges can be erected in a very short space of time.

Inglis Bridges.—A number of foot bridges were also required over the River Lawe in connection with the defence scheme.

The spans erected in each case were Inglis medium type bridges, of lengths varying from 48 feet to 72 feet.

No. 8 Class erected nine of these bridges in one working day of 10 hours, a notable achievement since the bridges were distributed over an eight miles length of the river.

ERECTION OF BRIDGES IN ARMY AREAS BY THE STAFF OF THE SCHOOL.

19. After the German advance in the Lys sector in 1918, a large number of bridges were required in the First and Second Army Areas near Aire.

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A portion of the Staff of the school was retained after the close of the ordinary courses at the school, to assist with these bridges. Forty-five bridges of various spans were erected under the supervision of the Staff. Also a number of spans were prepared and stocked for use in the event of an advance.

The labour employed was usually supplied by Formations in whose area the bridges were required.

ORGANISATION OF THE SCHOOL AFTER CESSATION OF HOSTILITIES.

20. The R.E. Bridging School was re-organised in December 1918, to take courses of 20 regular officers in bridge engineering and construction, in place of the ordinary classes of 20 officers and 100 other ranks.

The syllabus of these new courses includes applied mechanics, masonry structures, timber design, design of steel bridges and roof trusses, reinforced concrete and reconnaissance.

SCHEDULE A.

PROGRAMME OF WORK.

NO. 1 CLASS—OCTOBER, 1918.

1. PRACTICAL WORK.

Bridges to be Erected:—

No. 1. 120-ft. Hopkins on ¾ T. bankseats.
2. 85-ft. Class "A" (on girder only).
3. 75-ft. Hopkins on ¾ T. bankseats.
4. 60-ft. Mark II. on ¾ T. bankseats.
5. 30 ft. Reinforced and 22 ft. R. S. J. Field Span for Tanks, with Cube pier.
6. 60 ft. Mark II. and 20 ft. R.S.J. Field Span for Tanks with Cube Pier.
7. Pont Levis, 21 ft. 6 in. Class "A," and 16 ft. Mark II., with 2 pile piers.
8. 22 ft. R.S.J. Field Span for 12 T. Axle load on ¾ T. bankseats.
9. 20 ft. R.S.J. Field Span for Tanks on ¾ T. bankseats.
10. 25 ft. Bridge for First Line Transport.

Construction of Dam on R. Ternoise:—

SPECIAL WORK.

Date.	Group.	Squads.	Bridge No.	Work.
20th Oct. 1st day	1	A.B.	Dam.	Erecting 2 piledrivers and staging for same, transporting, preparing and driving piles.
	2, 3, 4	C. D. E. F. G. H.	No. 4	Preparing bankseats and launching tackle. Erecting Girders.
	5	J. K.	No. 7	Erecting piledriver and staging for same, transporting, preparing and driving piles.

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Date.	Group.	Squads.	Bridge No.	Work.
21st Oct.	1	A. B.	Dam.	Driving 2 piles.
2nd day	2, 3, 4	C. D. E. F. G. H.	No. 4	Complete erection of steelwork and preparations for launching.
	5	J.	No. 7	Driving 1 pile.
		K.	No. 1	Excavation for bankseats and setting out.
22nd Oct.	1, 3, 5	A. B. E. F. G. J.	No. 4	Launching and decking.
3rd day.	2	C. D.	Dam.	Driving 2 piles.
	4	H.	No. 7	Driving 1 pile.
		K.	No. 1	Preparing bankseats and erection packings.
23rd Oct. 4th day.	1—5	A—K.	No. 1	Erecting steelwork.
24th Oct. 5th day.	1—5	A—K.	No. 1	Erecting steelwork.
25th Oct. 6th day.	1—5	A—K.	No. 1	Erecting steelwork.
26th Oct. 7th day.	1, 2	A. B. C. D. G. H.	No. 1	Completing bankseats and erecting launching gear.
		E. F.	Dam	Driving 2 piles.
	3	J.	No.10	Erecting.
	5	K.	No. 7	Driving 1 pile.
27th Oct. 8th day.	1, 2, 4	A. B. C. D. G. H.	No. 1	Completing launching arrangements.
		E. F.	Dam.	Driving piles.
	3	J.	No.10	Completing.
	5	K.	No. 7	Driving pile.
28th Oct.	1—5	A—K.	No. 1	Launching.
9th day.	1	A. B.	No. 9	Transporting material and excavating bankseats.
	2	C.	No. 7	Driving pile.
		D.	No. 5	Erecting cube pier .
	3, 5	E. F. J. K.	No. 1	Fixing roadway and removing launching tackle.
	4	G.H.	Dam.	Driving piles.
29th Oct.	1	A.	No. 9	Completing.
10th day.		B.	No. 8	Erecting and Completing.
	2	C.	No. 7	Driving 1 pile.
		D.	No. 5	Erecting cube pier.
	3, 5	E. F. J. K.	No. 1	Fixing roadway and removing launching tackle.
	4	G. H.	Dam.	Driving 1 pile and fixing wales
30th Oct.	1	A.	No. 8	Removal and Re-erection.
11th day.		B.	No. 9	Removal and Re-erection.
	2, 4	C. D. G. H.	No. 1	Completing approaches.
	3	E.	No. 7	Driving 1 pile.
		F.	Dam.	Fixing wales.
	5	J. K.	No. 5	Assembling and launching 30-ft. Reinforced.
31st Oct. 12th day.	1—5	A—K.	Inglis Rectangular.	
1st Nov. 13th day.	1, 5	A. B. J. K.	No. 4	Dismantling decking and withdrawing.
	2	C.	No. 9	Removal and re-erection.
		D.	No. 8	Removal and re-erection.
	3	E. F.	No. 5	Erection of 22 ft. R.S.J.Span.
	4	G. H.	No. 3	Excavating for bankseats and setting out.

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Date.	Group.	Squads.	Bridge No.	Work.
2nd Nov.	5	A. B. J. K.	No. 4	Dismantling complete.
14th day.	2	C.	No. 8	Removal and re-erection.
		D.	No. 9	Removal and re-erection.
	3	E. F.	No. 6	Erecting and placing cube pier.
	4	G. H.	No. 5	Withdrawing 30 ft. Reinforced.
3rd Nov.	1	A. B.	No. 5	Erecting of 30 ft. Reinforced span.
15th day.	2, 4, 5	C. D. G. H. J. K.	No. 3	Erecting steelwork.
	3	E.	No. 9	Removal and re-erection.
		F.	No. 8	Removal and re-erection.
4th Nov.	2, 4, 5	C. D. G. H. J. K.	No. 3	Erecting steelwork.
16th day.	1	A.B.	No. 5	Erecting of 30-ft. Reinforced span.
	3	E.	No. 8	Removal and re-erection.
		F.	No. 9	Removal and re-erection.
5th Nov	1, 3, 5	A. B. E. F. J. K.	No. 3	Erecting, launching gear, launching and fixing roadway.
17th day.	2	C. D.	No. 5	Dismantling 30-ft Reinforced span.
	4	G. H.	No. 9	Removal and re-erection.
		H.	No. 8	Removal and re-erection.
6th Nov.	1, 2, 5	A.	No. 7	Driving 1 pile.
18th day.		B. C. D. J. K.	No. 2	Erecting steelwork.
	3	E. F.	No. 3	Completing approaches.
	4	G.	No. 8	Removal and re-erection.
		H.	No. 9	Removal and re-erection.
7th Nov.	1, 3, 4	A. E. F. G. H.	No. 2	Erecting steelwork.
19th day.		B.	No. 7	Driving 1 pile.
	2	C. D.	No. 2	Erecting launching gear.
	5	J	No. 9	Removal and re-erection.
		K.	No. 8	Removal and re-erection.
8th Nov.	1—5	A—K.	Dismantling tackle and returning to store.	
20th day.	1—5			

2 (*a*). LECTURES—OFFICERS.

Date.	Day of Class.	Subject.
Oct. 20th.	1	Types of Stock Spans, Army Bridge Depôts and Base Park. Hopkins Bridges.
21st	2	Piles and piledriving. Bending Moments and Shear.
22nd	3	Preliminary Reconnaissance and Reconstruction Schemes. Short Span Bridges for Heavy Loads.
23rd	4	Piers and Abutments, Part I. Piers and Abutments, Part II.
24th	5	Supply of Materials and Transport. Launching Methods.
25th	6	Organisation of Bridging Work on the site. Tackles and Anchorages, Part I.
28th	9	Aerial Reconnaissance. Tackles and Anchorages, Part II.
29th	10	Description and details of canals and streams in enemy territory and preparation of forecasts of Bridging requirements. Examination of Bridge Spans.
Nov. 1st	13	Organisation of a R.E. Coy., for Bridge Work. Inglis Bridge.
2nd	14	Preservation of Timber, Metal Work and Stores. Army and Corps Bridging Dumps.
3rd	15	Organisation and Equipment of I.W.T., Salvage Units.

N.B.—The first lecture will be at 11.30 hours daily and the second lecture at 17.00 hours.

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2 (*b*). LECTURES—N.C.O.'S AND MEN.

Date.	Day of Class.	Subject.
Oct. 20th	1	Types of Stock Spans. Piers and Abutments, Part I.
21st	2	Hopkins Bridges. Tackles and Anchorages.
22nd	3	Organisation of Bridge Work, Part I. Piers and Abutments, Part II.
23rd	4	Organisation of Bridge Work, Part II. Manipulation of Heavy Loads.
24th	5	Transport. Bridging Stores and Tools.
25th	6	Inglis Bridges.
26th	7	Sections of gaps.
28th	9	Reconnaissance and simple reconstruction.

3 (*a*). SCHEMES OR EXERCISES—OFFICERS.

	Issue.			Handing in.		
Date.	Day of Class.	Hour.	Exercise or Scheme.	Date.	Day of Class.	Hour.
Oct. 21st	2	12.30	Design of Pile Pier.	22	3	20.00
22nd	3	18.00	Design of Short Span Bridge for Tanks.	23	4	20.00
23rd	4	18.00	Design of Trestle Pier.	24	5	20.00
26th	7	08.00	Preliminary Reconnaissance Scheme for half Class.	28	9	20.00
27th	8	08.00	Preliminary Reconnaissance scheme for half Class.	29	10	20.00
28th	9	18.00	Design of Launching Tackle.	½ Class on 29th, ½ Class on 30th.	10 11	20.00
30th	11	08.00	Bridge Inspection Scheme for half Class.	Nov. 1st	13	20.00
31st	12	08.00	Bridge Inspection Scheme for half Class.	2nd	14	20.00

3 (*b*). SCHEMES OR EXERCISES—N.C.O.'S AND MEN.

	Issue.			Handing in.		
Date.	Day of Class.	Hour.	Exercise or Scheme.	Date.	Day of Class.	Hour.
Oct. 23rd	4	08.30	Organisation Scheme.	25	6	18.00
26th	7	08.30	Sections of Gaps.	27	8	12.00
28th	9	08.30	Reconnaissance and Reconstruction Scheme No. 1.	30	11	18.00
29th	10	08.30	Reconnaissance and Reconstruction Scheme No. 1.	31	12	18.00

NOTE.—A Table of Contents and list of plates, etc., of the Bridging Section will be issued in an early number of the *R.E. Journal.*

(Previous articles under the heading of "The Work of the Royal Engineers during the European War, 1914—19" appeared in the *R.E. Journals* of September, 1919 (Introduction p. 105; Anti-Aircraft Searchlights, France, p. 106; Postal Section—Army Postal Services, p. 114), October (Bridging, Chapter I., p. 162), November (Bridging, Chapter II., p. 200), December (Bridging, Chapter III., p. 261), January 1920 (Bridging, Chapter III., (*continued*), p. 13), February (Bridging, Chapter IV., p. 61; Organization of Engineer Intelligence and Information, p. 79), March (Bridging, Chapter V., p. 149). Copies of these Journals may be obtained through the usual channels.)

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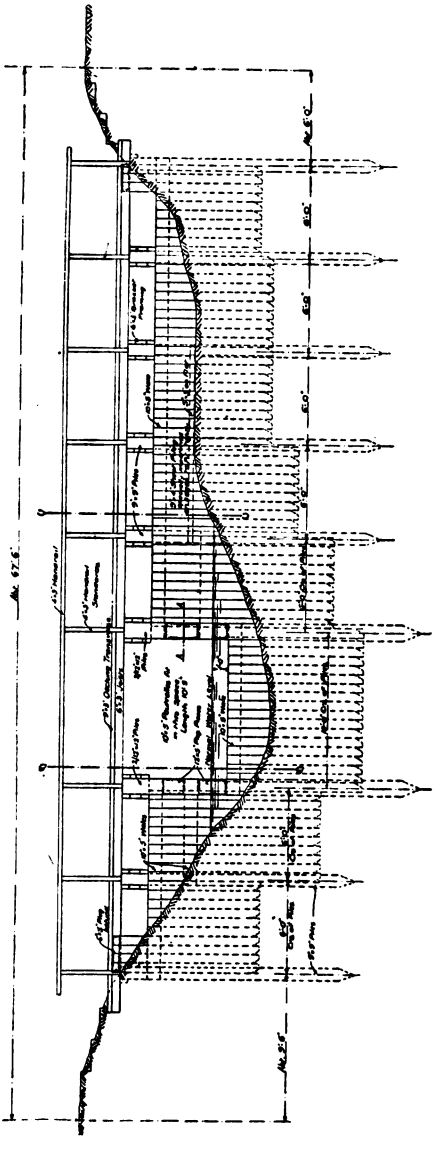
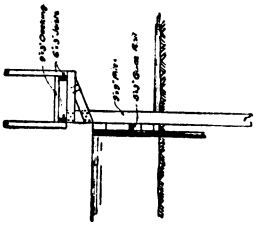
PLATE XXXII.

REPORT ON R.E. BRIDGING SCHOOL.

PROPOSED DAM AT R.E. BRIDGING SCHOOL.



— Elevation of Dam looking downstream —



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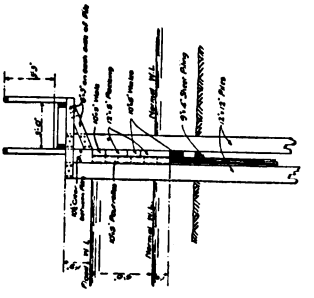

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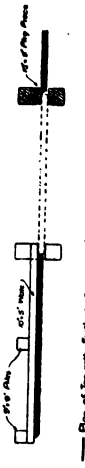

— Plan of Top with footings & supporting brackets removed — — Section AA —

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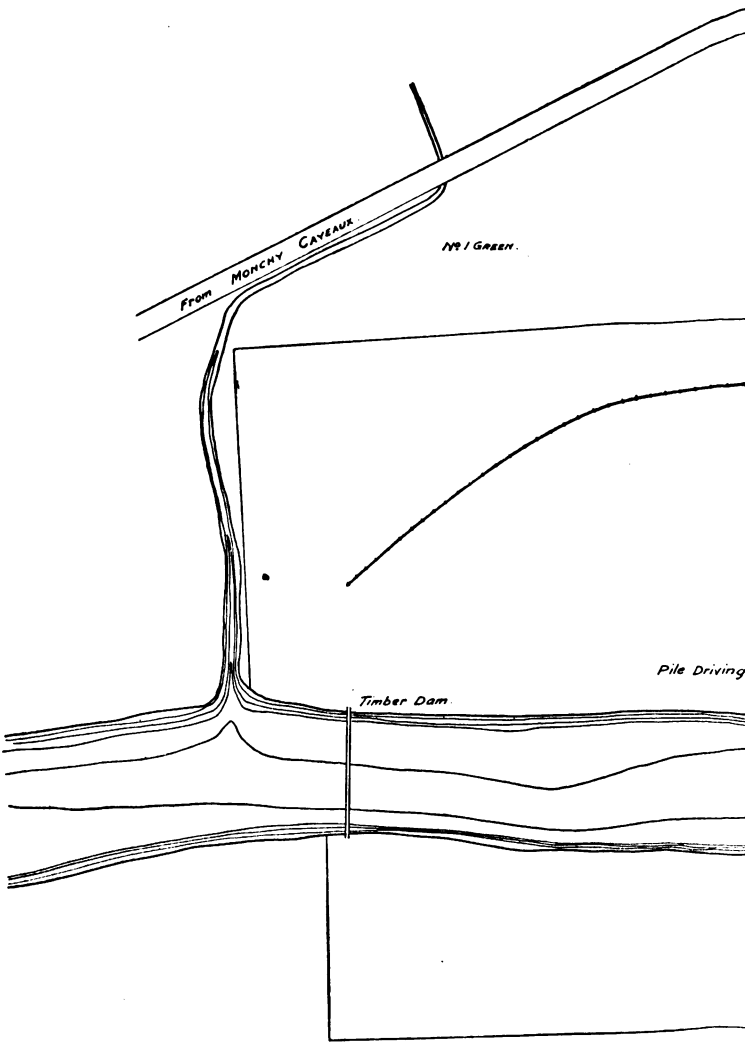

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THE BATTLE OF ARRAS.

REPORT ON R.E. PREPARATIONS FOR THE OFFENSIVE OPERATIONS ON 9TH APRIL, 1917,

By the C.R.E., 3RD DIVISION.

1. The 3rd Divisional Headquarters arrived at Warlus on 11th February and from two days after that the R.E. preparations may be said to have commenced.

The situation of R.E. and Pioneer *personnel* then was :—

56th Field Company R.E., just arrived at Arras.

438th (Cheshire) Field Company R.E. and 20th Battalion K.R.R.C. (Pioneers)—less 100 men employed on bunking barns—had been in Arras a few days, working under 12th Division.

529th (E. Riding) Field Company R.E., 2 sections at Warlus erecting Divisional Headquarters. One section at Wanquetin with 50 Pioneers erecting Nissen huts. One section at Liencourt bunking barns.

2. *Hutting.*—The hutting may be dealt with in a few words. The scheme was to increase the accommodation in the back area by erecting Nissen huts and bunking barns.

Shortness of material, largely due to thaw precautions being in force, delayed this considerably. Roughly speaking two sections of the 529th (E.R.) Field Company and 100 Pioneers were employed on it continuously from about 12th February to 5th April, and during that period erected :—

At Wanquetin	84	Nissen huts
At Liencourt	12	,, ,,
At Warlus	15	,, ,,

While 1500 bunks were constructed and 500 repaired in various villages.

3. *Preparations for the Offensive.*—These may really be said to have started on 15th February. Some two or three days were spent in finding out what was actually required, as the ideas of the 3rd Division did not agree altogether with those of its predecessor. Two excellent systems of tunnels made by the New Zealand Tunnelling Company, joining up various caves, were approaching completion, and full advantage was taken of the safe communication they afforded, the Brigade and Battalion Headquarters being made off the tunnels and thus provided with safe communications.

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The main items of work then decided upon were roughly :—

(*a*) Four main communication trenches 'Imperial,' '20th Street,' 'Iceland' and '1st Street.'

(*b*) Three Brigade Headquarters.

(*c*) Four Battalion Headquarters for 76th (front) Infantry Brigade.
Three Battalion Headquarters for 9th Infantry Brigade.

(*d*) Trench mortar emplacements for five Batteries of 2" T.M.'s.

(*e*) Circular trench and Cable trench to give lateral communication.

The above works (*a*) and (*e*), C.T.'s and lateral communication, were allotted to the Pioneers.

Each Field Company constructed the Headquarters for its affiliated Brigade.

Two Battalion Headquarters were constructed by each of the 56th and 468th (Cheshire) Field Companies.

The three Field Companies had nominally about 100 Infantry working with them up to about the middle of March, when the number was gradually reduced.

Other items taken in hand later on were :—

In the Ronville system of caves (to be used for assembling the 8th Infantry Brigade) the Pioneers constructed deep latrines, urinals and ablution benches, water being laid on by the VII Corps. Aladdin's Cave, found by accident by the Pioneers when digging the Circular trench, was cleared and three entrances were made into it, so that it could be used as a 'Q' dump, and some fifty pack animals stabled in it.

Three bridges, fit to carry any traffic, were made on roads where the Cable trench cut across them, by the 56th Field Company.

Advanced Divisional Headquarters.—A suitable site for these had to be found and gave some trouble. Eventually it was decided to utilise Russell Cave. This when cleared by the N.Z. Tunnelling Company was found to provide very little accommodation. The same Company then constructed a new dug-out close by which took all the Advanced Divisional Headquarters, except Signals, orderlies and officers' mess, which were placed in the old cave. The fitting up of this Headquarters was carried out by the 56th Field Company.

T.M. Emplacements.—One section of the 438th (Cheshire) Field Company was detailed for this as soon as it arrived in the area, and remained continuously at it, with working parties of R.A., T.M's and Infantry. Two sections of the 56th Field Company were also employed later on for a short period.

Originally five Batteries of Medium T.M.'s were to have been constructed, but owing to the retirement of the enemy from the front

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of our right most of these became useless, and eventually only five 2″ T.M.'s were used, besides Heavies.

4. *R.E. Dumps and Stores.*—An old workshop alongside the Girls' School was selected as the main R.E. Dump. The accommodation it afforded was limited, and later on as material came in another dump called Reserve Dump was formed on the Rue de Rietz.

The Pioneers established a dump of their own in the Rue du Temple.

Two advanced dumps were formed, well forward, just before operations commenced, one close to the original front line by 15th Street, the other just west of Strafe Wood.

The supply of materials at first was slow and scanty, partly on account of deficiency of transport, as thaw precautions prevented lorries from running for a considerable period, and partly due to a scarcity of materials, particularly of sawn timber and tools. It can hardly be said however that work was ever appreciably held up for want of materials (this does not apply to hutting) something which could be made to do was usually obtainable.

By zero day difficulties had been overcome and the dumps could be considered as fairly well stored.

Trench bridges and Trench ladders.—600 of each were obtained from the Army Parks. This number appears to have sufficed.

Artillery Bridges.—24 were obtained which sufficed.

The *tools* issued for the assault to the different Brigades were as follows :—

8th Infantry Brigade	300 picks	500 shovels	
9th ,, ,,	490 ,,	980 ,,	
76th ,, ,,	,, ,,	1000 ,,	

Q and Brigade Dump.—The Divisional Advanced Q Dump was in Aladdin's Cave, into which three entrances had been made, one of them large enough to admit pack animals, which were stabled in the cave until required.

Two or three of the old shafts were also fitted up with windlasses for hoisting or lowering stores. Water was laid on into this cave for filling petrol tins

Brigade dumps for S.A.A., grenades, etc., were made off the tunnels mostly by the Brigades themselves with R.E. supervision and assistance.

6. *Roads.*—(*a*) The main road in this area was the Arras-Cambrai road, a first-class *pavé* road, but cut about in our area by several trenches, three barricades, shell-holes, etc.

(*b*) Along the southern boundary ran a track, metalled for the first 500 yards to a very limited extent. Beyond that it was only a mud track.

The XVIII Corps undertook to make good the Cambrai road

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up to our front line, which they did, except that our Pioneers did the final filling-in of trenches and demolition of barricades.

They also undertook to make it good on the day of the battle up to just by the first German trench. Beyond this point up to the Bois des Bœufs had to be made passable for transport as quickly as possible.

The Intelligence regarding this portion gathered from aeroplane photographs showed that nine trenches crossed it and that certainly one large pit, probably 25 feet wide, and six feet deep, had been dug right across it; possibly also two others, and two barricades also existed at Tilloy. This intelligence proved fairly correct, but the barricades were destroyed by artillery fire. Only one pit was found and this was more of the nature of a very wide trench with a barricade of agricultural implements, and it was not so wide as anticipated. To deal with this road one section 529th (E.R.) Field Company and the 20th K.R.R.C. (Pioneers) (less 1½ platoons) were detailed, with the Pioneer Battalion of the 37th Division as second relief and the N.Z. Tunnelling Company and one A.T. Company R.E. as third relief.

The scheme was, briefly, for the section R.E. to erect a trestle bridge over the pit, using one of their Weldon trestles and superstructure for the purpose, this being carried up by hand. All other trenches to be filled in and corduroyed with sleepers. A single track for horsed transport to be got through first, and then widened, made fit for lorries, etc.

Tools were collected and about 2500 sleepers, supplied by the Chief Engineer VI Corps, disposed in dumps by the Pioneers.

All parties of the 20th K.R.R.C. were *very* carefully organised, told off each to a definite trench, and tools and materials allotted beforehand.

On the 9th April at 9.15 a.m. the liaison officer of the XVIII Corps was ordered to commence work on his portion. At 9.25 a.m. the first company of the Pioneers was ordered to move up, but on reaching the spot found it too hot to work for another two hours, and suffered ten casualties. The remainder of the Battalion, and the section of the 529th (E.R.) Field Company were ordered up at 1.30 p.m., and got on all right with the work.

A track ten feet wide and fit for lorries (it is doubtful if this was the case at the trestle bridge) was reported through at about 10.0 p.m. on the 9th.

On the 10th the Chief Engineer VI Corps assumed charge of the road.

The track along the Southern Divisional Boundary was wanted to enable Field guns to get forward. 1½ Platoons of the 20th K.R.R.C. (Pioneers) were allotted to this. Trenches were prepared for bridging and material collected. This party under Lieut.

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Thomas was ordered up at 9.15 a.m., and the track was ready by the time the guns arrived. Continued heavy traffic, coupled with wet weather, destroyed it and it became hopeless unless corduroyed throughout. No more sleepers were available for it after the 12th. A good deal of work was done on it by the Field Companies in the meantime, but it dropped out of use.

Two level crossings were made just north and south of Arras Railway Station in case either of the bridges was destroyed, and in order to provide additional road facilities. Their value was fully proved when the bridge north of the Station blew up.

Allotment of R.E. and Pioneers for the Offensive.—The three Field Companies were allotted for work on 9th April as follows:—

With the 76th I. Brigade.—2 Sections 529th (E. Riding) Field Company with two platoons 2nd Battn. Suffolk Regt. Half a section and one platoon Suffolks were employed in improving the Push Pipe crater just south of the Cambrai road for use as a C.T., and on digging through the lip into a German sap. The Push Pipe was exploded at 5.30 a.m. and formed a crater about 15 feet deep. At first there was a considerable amount of shell-fire here and the casualties amounted to 5 R.E. (20 per cent.) and three Infantry.

At 9.5 a.m. these Sappers moved forward to join the other 1½ sections in constructing strong points in the German first line system. The platoon finished the C.T. by 1.0 p.m.

The two sections altogether constructed three strong points on the 9th and another on the 10th.

With the 9th I. Brigade.—56th Field Company and two platoons of Infantry attached. Three sections with an Infantry party constructed three strong points in the Harp, east of Tilloy and west of the Quarry. The 4th section erected a screen on the Cambrai road on the night 8th—9th to cover the advancing battalions from view from the north, and afterwards examined German dug-outs and put a well in Tilloy into working order. Casualties 1 officer and 2 men wounded. The strong points were completed by 4.30 p.m. On the 10th April the Company was employed in wiring the Blue line.

With the 8th I. Brigade.—Two sections 438th (Cheshire) Field Company and two platoons 1st Battn. R.S.F. These were moved up at noon on the 9th, but as the Brown line had not been captured they were sent back again. On the 10th they were again sent forward and after the capture of the Brown line constructed two strong points in it. Later on they cut gaps in the wire for cavalry to pass through. Casualties 3 wounded.

Of the remaining R.E., one section of the 529th (E.R.) Field Company was employed in erecting the trestle bridge in the pit on the Cambrai road, as has already been mentioned. The remaining section of this company and one section of the 438th (Cheshire) Field Company were employed in the evening of the 9th on the South

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Artillery track, the remaining section of the 438th being detailed for fire duty in Arras.

On the 10th these three sections were all employed on the South track. On the 11th, 12th and 13th all the three Field Companies were employed on the South track, except that on the 11th and 12th the 529th (E. Riding) stood by for 48 hours in the Bois des Bœufs ready to consolidate Guemappe when taken, and on the 13th two sections of the 56th Field Company acted similarly In neither case were they used.

When not at work the Companies lived in their cellars in Arras.

The employment of the Pioneers was entirely on roads and has been already described. In addition, on the night 8th—9th a hundred of them were sent off to dig out five Tanks which had stuck near the Citadel. They succeeded in freeing three of them.

No particular new lessons are apparent, but the value of the careful and thorough preparations, which worked without a hitch on the day, must be recognised.

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SOME MORE BOOKS ON THE WAR.

By BRIG. GENERAL J. E. EDMONDS, C.B., C.M.G.

THE list of books mentioned in this article is of course by no means exhaustive, and the writer would be glad to hear of others of value that any R.E. officer may come across.

FRANCE.—Some very valuable books on the operations of the early part of the war have appeared in Germany. These are the "Die Schlacht bei Mons" (2·30 marks) in the series of German General Staff Monographs published by Stalling. Even without a knowledge of German, the maps which show the advance of von Kluck's divisions, and the plans of the battles, will tell the military student a great deal. In the same series "Die Schlacht bei Longwy" gives a truthful account of the fighting of the German Fifth Army and entirely disposes of the Crown Prince's claim to a victory.

A translation of "Ypres" (5s.) has already been noticed in the *Journal*.

Another very important book is "Mein Bericht zur Marneschlacht" (9 marks) by Generaloberst von Bülow. It describes the operations of the First and Second Armies, both of which were most of the time under his command, from the commencement of the campaign until the end of the Battle of the Aisne. It is indispensable to the student on account of the operation orders and maps. There are also a somewhat fuller story, "Die Marneschlacht 1914" by General-major Baumgarten-Crusius (5 marks), which covers the same period, and the story of the German Third Army by its Commander General Oberst von Hausen:—"Erinnerungen der Marnefeldzug 1914" (24 marks). The maps, etc., in the above books enable the campaign up to the Aisne to be followed in detail, and make General Sir F. Maurice's clever patchwork in his "First Forty Days" obsolete. Von Kluck's Memoirs are in the Press and a translation is being prepared by Messrs. E. Arnold & Co.

Of French books, "Le Revers de 1914 et ses Causes" (4·50 francs) by Col. de Thomasson and "L'Erreur de 1914" (4·50 francs) by General Berthaut give a clear account of the reasons for the French plan of campaign and the opening moves. "Le Vérité sur le Siège de Maubeuge" (3 francs) by Commandant Cassou has an authoritative account of the siege by a staff officer who was present. "Le Rôle de la Cavalerie Française" (4·50 francs), by J. Hethay presents a good picture of the activity of the French cavalry and

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particularly of the raid on to the German L. of C. during the battle of the Marne. "Lille" (4·50 fr.) by General Percin explains why, by order of the Government, Lille was not defended.

For the closing phase of the campaign there are Major Gen. Sir F. Maurice's "The last four Months (7s. 6d.) which also deals with the causes of General Sir H. Gough's defeat, and a very similar book in French "La Bataille Decisive" (3 francs) by Capitaine R. Hoff.

MESOPOTAMIA.—One is glad to be able without partiality, favour or affection to place Major E. W. C. Sandes' book "In Kut and Captivity" (24s.) among the best books on the war. His clear and unpretentious narrative gives the military history of the campaign from just after the victory of Shaiba until the surrender of Kut, and narrates his subsequent captivity. As commander of the Bridging Train he tells us a good deal of special engineer interest. Mr. Candler, who was an official press correspondent, in his "Long Road to Baghad" (2 vols. 40s.) practically carries on the story from the time Major Sandes leaves off. Like the road he describes, the book is somewhat long, but apart from his complaints of the censorship it is far from wearisome. "In Mesopotamia 1914—5" (9s.) Major Reynardson, who was with the first division that left India for the Persian Gulf, tells an interesting story from the regimental officer's point of view. In "Four-Fifty Miles to Freedom" (7/6), Captains Johnston, R.A. and Yearsley R.E. give a dramatic account of their escape from captivity, good enough from a literary point of view to be reviewed in the *Athenæum*. "The Road to Endor" by E. H. Jones, Lt. I.A.R.O. (8/6) is a fresh example of the adage that truth is stranger than fiction.

Major General Townshend's book has been appearing in parts in the *Sunday Times* and will no doubt be available shortly in volume form. He is very outspoken in his criticism of the Higher Command.

PALESTINE.—"The Advance of the Egyptian Expeditionary Force July 1917 to October 1918," published by H.M. Stationery Office (6s.) contains a brief military account with numerous excellent situation maps of Lord Allenby's advance, followed by a number of chapters on technical work, including some on R.E. matters. The credit of the success of the campaign is largely given to the R.E. and R.A.M.C. in spite of cavalry having been present.

Major Lock's book "With the British Army in the Holy Land" (7s. 6d.) provides a good deal of local color and sound history. He joined the Palestine force after the first and second reverses at Gaza. A great deal of information will be found in W. T. Massey's two volumes (21s. each) "The Desert Campaign" dealing with the advance from Egypt to Gaza, and "Beersheba to Beeroth—How

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Jerusalem was won," A further volume is to describe the great advance.

SALONICA.—"Salonika and After" (10s. 6d.) by H. Collinson Owen, who edited the *Balkan News*, provides a mass of local color and towards the end of the book a short clear sketch of the operations. The beautifully illustrated "Salonika Front" (25s.) painted by W. T. Wood and described by Captain A. T. Mann goes somewhat deeper into the operations.

EAST AFRICA.—Br. General Crowe's "General Smuts Campaign in East Africa" (10s. 6d.) is a good military account of that period. The best book of local color, F. Brett Young's "Marching on Tanga" (10s. 6d.) covers the same time, so one is thrown on despatches at present for the remainder of the campaign unless one goes to the German story. Lettow Vorbeck's own is told in "Meine Erinnerungen aus Ostafrika" (20 marks), which will shortly be issued in an English translation, Dr. Deppe's "Mit Lettow-Vorbeck durch Afrika" (24 marks) is also most valuable; it is full of detail, has 300 illustrations and contains a good account of the original attack on Tanga, where he was in charge of the hospital.

Edmund Dane's volume "British Campaigns in Africa and the Pacific 1914–18" (7s. 6d.) is weak except in the account of the campaign in South West Africa.

GALLIPOLI.—"The Dardanelles" by Major General Sir C. E. Caldwell (18s.) is a valuable addition to the literature of Military History and should be carefully studied. The final report of the Dardanelles Commission (Part II., Conduct of operations, with appendix and maps, 2s. net) is now on sale at H.M. Stationery Office.

NAVAL OPERATIONS.—Sir Julian Corbett's first volume of the official naval history is expected to appear in March. I am informed that Mr. Pollen's "The Navy in Battle" contains a good general account of the war on sea. Of German books there are "My Memoirs" by Grand Admiral von Tirpitz (translated 2 vols., 28s.), probably the most truthful book yet written on the war; and Captain Persius' "Seekrieg" with a bitter attack on von Tirpitz. "The Battle of Jutland" by Commander Bellairs is most interesting, and though necessarily founded on gossip and hearsay, probably, goes very near the truth. "The Dover Patrol 1915—17" (two vols. 34s.) by Admiral Sir R. Bacon is of special interest to soldiers as it tells the story of how the Channel was held, though we shall look with more interest at a book by Admiral Bacon's energetic successor, Admiral Sir R. Keyes, if he ever writes one. One of the most entertaining books on the War is "The Indiscretions of the Naval Censor" (21s.) by the late Chief Naval Censor, Admiral Sir R. Brownrigg.

GENERAL.—Of the many memoirs published, Ludendorff's "My War Memoiries 1914–18" (translated 2 volumes 34s., in German

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one volume 18 marks), and Falkenhayn's "General Headquarters 1914—1916 and its Critical Decisions" (translated 24s., in German 18 marks) are disappointing; they go very fully into the successes in Russia but say little about the West; in fact Ludendorff stops short of the preparation for 1918, and Falkenhayn only gives $3\frac{1}{2}$ pages to the Battle of the Somme and about 7 to Verdun. Lord Haldane's "Before the War" (7s. 6d.) clears up his relations with the German Court before 1914, but tells us little of what he did as War Minister to prepare the Army for the inevitable war.

Some other books of interest are Count Czernin's "In the World War" (translated 25s.), the memoirs of a very cynical diplomat; "A Private in the Guards" (10s.,) by Stephen Graham, a much discussed book which relates the experience of rough handling suffered by a temporary soldier as a recruit, and his life at the front; and "the Press in War Time" by the late Sir Edward Cook, co-director of the Official Press Bureau. A book called "Sapper Dorothy Lawrence" should be noticed; the lady's only claim to the rank she uses is that a friendly Tunneller provided her with uniform and she got up to the front for a day.

TECHNICAL.—The only technical book that has come to notice is "Le Service des Routes Militaires 1914—19" (5 francs) by Lt. Col. Lorieux, Assistant Chief of the Service of Military Roads. It contains an excellent account of the French system with reproductions of photographs of roads, quarries, bridges, etc. and maps.

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THE SIGNAL SERVICE WITH THE EGYPTIAN EXPEDITIONARY FORCE.

Reproduced with the sanction of the Controller of H.M. Stationery Office from "A Brief Record of the Advance of the Egyptian Expeditionery Force, July 1917 to October 1918":—

A BRANCH of the Royal Engineers that merits a separate chapter is the Signal Service. The nature of the operations, the rapid and wide movements, and the great distances traversed, which have been special features of our operations in Palestine, made the problems of intercommunication peculiarly difficult. The sharp changes from soft sandy deserts to rolling pasture land passable by wheels, and then to mountain tracks where lines could be laid only by hand, and material conveyed by pack animals, called for much elasticity in transport, and ingenuity in methods of building telegraph lines. The necessity for long distance speech from the front to the base required the provision of telephone trunk lines as long as from London to Aberdeen. The volume of traffic to be dealt with has involved the use of delicate apparatus for high-speed automatic telegraphy, under very trying conditions of dust and damp; and its successful employment is entirely due to skilful handling by the telegraphists, and to the watchful tending of the instrument mechanics.

An expeditionary force operating in such varying circumstances necessarily has to undergo many changes in organization, and each alteration in the organization of a force involves corresponding changes in the means of communication. Not only does this apply to actual lines and offices, but to the organization of signal *personnel.* On the formation of the XXth and XXIst Corps, new companies and sections to meet the demands of these headquarters were necessary, and to a great extent were improvised locally. This improvisation has certain advantages, *e.g.*, the officers and men are accustomed to local conditions but, on the other hand, the older units have to suffer from the withdrawal of officers and men. Besides these major changes in organization, there are always others going on, due chiefly to an ever-extending line of communication, but also to additional means of signalling such as pigeons or "trench" wireless and to the re-grouping of units and formations. This all means, that, while the Signal Service is functioning as a whole, the parts are constantly being altered and improved, and the smooth working of the machine must go on owing to elasticity of the organization and the adaptability of individual members.

The system of intercommunication built up to July, 1917, con-

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sisted of: (1) the tactical cable and airlines between East Force Headquarters and the battle front, which included special artillery, Royal Flying Corps and other circuits; (2) the main backbone of semi-permanent lines connecting East Force Headquarters (near Deir el Belah) with the Kantara base (about 140 miles away); (3) the permanent lines within Egypt connecting Kantara to Cairo, Alexandria, Port Said, Suez, and to our cables to Europe, India, and Australia.

During September and October, of 1917 with the prospect of an advance, signal units were very busy—in addition many had only recently been formed, and still had to continue training. Behind the battle area, the increase in administrative services and the doubling of the railway line entailed an expansion of the Lines of Communication Signals. Not only were the local telephone systems continually growing, but means of maintaining telephonic communication with Egypt as the force advanced required the previous building of heavier trunk wires. To economise men, as the lines lengthened, the old Turkish desert telegraph lines had to be replaced by new lines along the railway, where maintenance is easier. Forward units with the assistance of infantry and artillery were engaged on elaborate buried telephone systems in the shelled areas. Alternative routes were so developed that any battery, for example, could always ring up any observation post or artillery commander, even if some of the main lines were cut. Preparations for the attack on Beersheba and the maintenance of communication with the cavalry on their long march of envelopment also involved much careful preliminary work and training. Material for airlines and cables was laid out and concealed ready for rapid laying when the flag fell. Three cables accompanied the cavalry and these were patrolled constantly by horsemen left at test points every five or six miles. Although the lines were cut, one or more of the three were always in working order and communication was preserved throughout the enveloping attack.

When "Z" day arrived and Beersheba was captured, rapidly erected permanent wires were substituted for the long cable lines which had been laid round by way of Asluj. A network of cables spread out from Beersheba to the north and north-west as the flank attacks on the main Turkish positions progressed. When mounted troops advanced, wireless communication came into use to keep touch with the rear. When Gaza fell, lines were rapidly extended up the main road and along the railway. Gaza, Beit Hanun, Deir Sineid, Mejdel, each in turn became railhead where local telephonic systems were rapidly installed. Among the troops advancing, divisional and corps signal units were ever at work coping with the constant forward jumps of their headquarters. For two months this process continued in difficult country and during severe climatic

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changes. Then, as warfare became less mobile, more elaborate forms of forward communications grew, involving alternative means of all sorts. In rear the railway and its telegraphs advanced, and as Ludd became railhead there grew up the usual telephone system. Jerusalem, Ramleh, and Jaffa were all linked up, and became important centres; while Jericho served as the focus of intercommunication for the operations across the Jordan.

During the summer of 1918, while big changes in the constitution of the force were in progress some signal units had largely to help units of other arms who were short of trained signallers in maintaining their telephonic systems. Assistance was also given in the training on a large scale of regimental signallers in Corps Signal Schools. A very large increase in the number of signallers was effected in Indian Army units. The more prosaic side, such as the improvement, and in some instances multiplication of lines in rear, and the transmission of masses of telegrams, numerous telephone calls, and messages by despatch rider, went on continuously through 1918.

Early in September, preparations had to be made for the final battle of the war with the Turk. The wonderful secrecy of all the preliminary arrangements necessitated limitations to the amount of work that could be done in certain directions. On the other hand, considerable scope to ingenuity was given by opportunities for misleading the enemy. For instance, the leaving of signal stations in their old places, the continuation of work as usual and the building out of dummy lines, and special telephone exchanges built only for purposes of deception, helped to mask our intentions.

Finally, when the cavalry had moved across to the left flank and all was ready, the " break through " was effected. As is well known, the advance of the cavalry averaged some sixty miles during the first twenty-four hours. As soon as the cavalry divisions got to their positions across the line of retreat of the Turks at Afule and Beisan, telegraphic communication was established between these points and General Headquarters near Ramleh by rapid building and repairs to Turkish lines. Thus the movements of cavalry working northwards from Ghoraniyeh and southwards from Beisan—closing the ring—could be co-ordinated. It must not be forgotten that other forms of telegraphy—visual and wireless—and motor cyclist despatch riders were also playing their important part.

To resume, after the major portion of the Turkish army had been surrounded the freer movements of the cavalry made still greater calls on their signal units. One day's march from Afule led to the capture of Haifa, and, though this was an advance of about thirty miles over new territory, the capture was reported from just outside the town by telephone to the Desert Corps Headquarters at Megiddo (Lejjun) the same afternoon.

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During the subsequent advances to Damascus and Aleppo, telegraphic communication to advanced troops was usually obtained as soon as these halted. The method employed was to mount parties of linemen in motor cars with the necessary material and implements, and so effect rapid repairs to existing wires. Subsequently, the patched-up lines have to be thoroughly overhauled, and for many weeks after the army is at rest the cable and airline sections of the Signal Service are kept hard at work re-building, and adding to the telegraph system in the occupied territory.

For those who appreciate figures, it may be of interest to picture the "traffic" dealt with at various places:—

Average number of words telegraphed daily at

(*a*)	Divisional Headquarters	12,000
(*b*)	Corps Headquarters	25,000
(*c*)	General Headquarters	90,000
(*d*)	Kantara	60,000

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Major-General Sir Philip Geoffrey Twining,
K.C.M.G. C.B., M.V.O.
Director of Fortifications and Works.

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MEMOIR.

MAJOR GENERAL SIR PHILIP GEOFFREY TWINING, K.C.M.G., C.B., M.V.O., DIRECTOR OF FORTIFICATIONS AND WORKS.

By the death of Major General Sir P. G. Twining which, as already reported in the *Supplement to the R.E. Journal* for February, occurred suddenly in London on the 15th January last, the Corps of Royal Engineers lost both its senior official representative at the War Office and one of its ablest officers. It is in fact difficult to appraise the loss suffered. At the present time when the future of the whole British Army is in the making and when wise counsels and clear judgment are vitally necessary to remould the machine to fit in with the new conditions the Corps was indeed fortunate to have such a man as Twining at its head. It will be of interest to all, and we think not without value to the younger Officers, both of this and of future generations, if we trace his career from boyhood, and attempt to discern the forces which moulded the man and to indicate those qualities upon which his success depended. To assist us in this task we have asked his contemporary and lifelong friend, Major General A. C. de L. J. de Lotbinière, C.B., C.S.I., C.I.E., to give some account of his earlier years, and he has kindly supplied the following :—

Philip Geoffrey Twining was born in Halifax, Nova Scotia, in 1862. He joined the Royal Military College, Kingston, Canada in 1880, and graduated in 1883, obtaining a first class certificate which qualified him for a commission, if available, in any branch of the British or Canadian forces.

I cannot say that he took his studies very seriously or that he did more than the minimum amount of work requisite to ensure his successful graduation. To his contemporaries he would be remembered mainly as an outdoor man, taking the keenest interest in all forms of sport. He played full back in the College Rugby team and as an example of his pluck and determination when his collar-bone was badly fractured in an important match he stuck it out to the end thus enabling his side to draw the game. He was also a prominent member of the cricket eleven and excelled at tennis. Though on graduating he had qualified for a commission there was then none available. The only commission given was one to the head of the batch and Twining did not finish more than half way

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up his class. It was therefore necessary for him to adopt a profession. I was in the same position and we both decided to take up mechanical engineering. We realised that to attain success practical knowledge and experience were the first necessities, and that we must be in a position not only to order work to be done, but, if necessary, to do it ourselves. We therefore took employment as journeymen fitters in the leading railway shops in the United States and Canada with the object of familiarising ourselves with the details of railway work and practice. The life was in truth not an easy one. In those days work began at 7 a.m. and lasted till 6 p.m. with one hour's break for dinner and no holiday except Sunday. The manual toil was severe and to Twining, who, though physically no weakling was never endowed with a very vigorous constitution, it required great determination to carry on. The conditions were entirely different from those imposed on the educated engineering apprentice in this country and with all their hardness carried advantages that more than compensated. In no other way would it have been possible to arrive at the close knowledge of the rank and file, of their views and their mode of life, knowledge which in after life gave true authority, born of intimate and practical experience. For three years Twining lived this life and moreover entirely supported himself on the pay he earned. The rate was only 2s. 6d. per day for the first year, rising to 5s. 6d. in the third year, a rate obviously insufficient for more than the barest necessities. It was his pride that he cost his father almost nothing during the whole time. On such an anvil was his character forged during the most malleable years of his life.

Late in the autumn of 1885 our chance came and our outlook was suddenly enlarged. At that time this country was going through one of its periodical and probably inevitable war scares and it was decided to make a substantial increase in the establishment of R.E. Officers. Twenty-five commissions were accordingly offered to graduates of the Royal Military College, Kingston, among which Twining and I were fortunately numbered.

I well remember the receipt of this news. We were engaged in re-making a steam joint on an engine, just in off the line. Twining was working in the smoke box, in a condition of heat and dirt which needs no emphasis and I was handing tools to him, when a telegram arrived conveying the joyful intimation that Her Majesty Queen Victoria had honoured us by the offer of commissions in the Royal Engineers. I need hardly say that we had no hesitation as to where our duty and our inclination lay and we quitted our work and our status as workmen possibly without much feeling of regret at the moment but carrying in us a strong conviction, which has deepened as years go by, that we had immeasurably gained by our strenuous experience.

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We joined at Chatham in January, 1886, and after eleven months at the School of Military Engineering were considered qualified for foreign service. We both chose service in India and embarked in February 1887. On arrival in India our ways parted and since that date while always keeping up an intimate friendship we did not actually serve together until our return from France in 1918.

Twining's career in India was a varied one and gave him ample opportunities, of which he did not fail to avail himself, of acquiring knowledge of his profession and of the needs of the Army generally. He served for a time in the Bombay Sappers and Miners at Kirkee and was employed on various official services on the North West Frontier.

In 1890 it was decided to make a reconnaissance survey of the route of a railway in the neighbourhood of the Khaibar Pass. The organisation of the survey party and the direction of the operations were entrusted to Major General Sir J. R. L. Macdonald, K.C.I.E., C.B., then Captain R.E., and Twining was chosen as one of his staff. The success of this work led to a similar operation in the Zhob Valley, and, in 1891, to the more important survey of the route of the proposed Uganda Railway, in both of which Twining took part. The history of this last operation is well-known and need not be recounted here.*

On completion of the work he was selected for an appointment on the instructional staff of the Royal Military College, Kingston, and served there in the office of Professor of Military Engineering from September 1892 to June 1898. Here as always Twining threw himself heart and soul into the task at hand and left a fine reputation behind him when he departed. His teaching was animated and inspired by his faculty for grasping essentials and for expressing them in a simple, direct and convincing style. He himself doubtless gained enormously by this experience of teaching and by the valuable practice it gave him of clothing his thoughts in words. The succinctness and clarity of his memoranda and reports, a quality so invaluable to a staff officer and which he exhibited so remarkably when he was called to high office, were largely a fruit of this time.

He returned to India in November, 1898, and from then to 1914 held a number of important posts. In 1900 he proceeded to China with the Expeditionary Force as D.A.A.G. (special service), being twice mentioned in despatches. He was afterwards in succession :— Inspecting Officer Imperial Service Troops Punjab ; A.A.G., Army H.Q. Staff Simla, and Commandant 1st K.G.O., Sappers and Miners, to which responsible command he was appointed while still a Major in the Corps. This post had never before been held by such a junior officer.

* See *R.E. Professional Papers* No. 1 of 1897 (Vol. XXIII.).—Ed. *R.E.J.*

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From the foregoing narrative it will be clear that Twining's career in the service for the twenty-eight years from 1886 to 1914, while a distinguished one, was in no way pre-eminently remarkable, nor was it such as to elevate him above many other able and successful men. In his case, as with so many officers, it was the war that really proved him and disclosed of what sterling metal he was fashioned. His career during the war was marked with one uniform characteristic, a complete mastery over all the difficulties of every successive post he occupied. He thus naturally and inevitably rose from post to post, finishing in the highest position our army system offers to the Engineer Officer as such. In 1914 he went to France as C.R.E. Meerut Division afterwards acting as A.Q.M.G. During this early period of the war he took a prominent part, with the Officers of the Bengal Sappers and Miners, in devising and experimenting with a weapon which later attained such importance, the hand grenade. The earlier improvised form, the so called jam tin grenade, was largely due to his ingenuity. The actual construction of such a weapon is however a comparatively small thing. The real advance was to see clearly, even at the very beginning of the trench warfare phase of the combat, that a short range weapon of this class was an absolute necessity and that the army which had one at its disposal must reap a commanding advantage. Twining's clear vision and unerring sense of realities shewed him this and he took every opportunity of forcing upon those concerned the imperative need of starting the manufacture of bombs and grenades upon a very large scale.

On the return of the Indian Division to India he was retained in France and appointed D.A. & Q.M.G., XIII Corps. His services were then specially asked for by Sir E. Geddes for the position of Director of Light Railways and Roads, a post which developed later into that of Deputy D.G. of Transportation, G.H.Q. Finally the last position he held in the field was that of D.A. and Q.M.G., 1st Army.

It is almost needless to say that during the 3½ years that he thus spent in France he was closely engaged in much of the actual fighting. The early time with the Indian contingent covered the whole period of the struggle at Neuve Chapelle. While with the XIII Corps he took part in all the heavy battles on the Somme, in which that Corps was particularly prominent and distinguished. Later on, when serving with the 1st Army, he was present at many of the critical operations during the advance of 1917.

Early in 1918 the office of D.F.W. became vacant and Twining was selected. This selection, being quite outside what would have appeared to be the ordinary lines of promotion, doubtless caused some surprise to those who did not know the man and the character of his work. To those who did know him and who had

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watched his steady ascent and seen the splendid adequacy with which he rose to every occasion the appointment was a matter of sincere rejoicing and was moreover patent and clear evidence that no consideration, save the sole one of his fitness for the position, had been given any weight. How amply the selection has been justified is known to all those acquainted with the history of the Corps during the past two years. We are not in a position here to attempt any sort of summary of what he has actually accomplished; in the first place it is too early for such an attempt and in the second, if we read the signs correctly, it is not so much actual accomplishment, his time of office was alas too short for this, but rather that he succeeded in giving things the initial impulse and starting them upon the right roads.

In summarising Twining's character and in estimating the qualities that brought him to the front it will suffice to dwell upon three main points. Firstly we may lay stress upon the uniform equability of his temperament resulting in a delightful courtesy of manner and a rare measure of consideration for the feelings of all those with whom he worked; secondly upon his deep sincerity of purpose and his innate determination never to let anything stand between him and his ideal of duty—he truly lived his life to the full, giving always the best of which he was capable; and thirdly his penetrating insight and power to see realities and disregard unessential details, aided by his faculty for setting forth his ideas in clear and convincing language. His life is full of example and encouragement to others and will we trust long remain an inspiration to the many able young officers that we can fortunately number in the Corps.

Of material rewards and recognition he did not lack. For his services in France he was eight times mentioned in despatches, and received numerous honours, including C.B., Legion of Honour, Grand Cross St. Avis of Portugal, Order of St. Stanislaus—2nd Class, American Military Service Cross, and culminating in the K.C.M.G. At the time of his appointment as D.F.W. he was in a poor condition of health, his exhausting labours had stretched almost to the breaking point a constitution never robust and it was some time before he was sufficiently recruited to assume office. He made however a wonderful recovery and it was hoped by his friends that many years of health and hard work were yet before him. An old trouble however recurred and carried him off with tragic suddenness.

During the time he was on the staff at Kingston he married Miss Louise Daly who survives him. He leaves no children.

In conclusion we may perhaps be allowed to quote extracts from letters which confirm and emphasise the points we have already briefly mentioned.

The Secretary of State for War wrote:—"By General Twining's

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death the Army lost a gallant and devoted officer and the State a loyal and untiring servant. His personality endeared him to all who came in contact with him and his presence will be sadly missed."

General Lord Horne wrote :—" General Twining was a man for whom I had the greatest admiration and sincere affection. He was a splendid character, staunch, loyal, true, courteous, kind ; a perfect gentleman and a fine soldier. There are few like him."

General Sir W. Furse, K.C.B., until recently his chief at the War Office, wrote :—" Of all the good fellows with whom I have come in contact during the war I never met a man more delightful to work with or one in whom I felt such complete confidence. I had the greatest respect for him and a real affection."

Complete confidence, a deep respect, and a sincere affection were inspired by Twining with everyone with whom he came in contact and what richer praise can we give a soldier and a man ?

A. J. DE L.

To the letters already quoted the following two may be added :—

16th January, 1920.

DEAR LADY TWINING,—On behalf of the Corps of Royal Engineers I am anxious to express to you our most sincere sympathy on the death of your husband.

In losing him we have all of us lost a brother Officer who was a friend to each of us and who did his utmost to help the Corps to carry out its work in the best interests of the Service.

We mourn his loss deeply and we desire to share with you a little of the grief which we know is yours.

Yours sincerely,

R. H. H. BOYS, *Brig. Gen. A.A.G., R.E.*

To this Lady Twining replied as follows :—Will you please convey to the Corps of Royal Engineers my sincere thanks for their sympathy in my loss and the deep appreciation I feel at their expressions of affection and appreciation of my husband's work.

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REVIEW.

THE DESIGN OF SCREW PROPELLERS FOR AIRCRAFT.

By H. C. WATTS. (Longmans, Green & Co., E.C.4. Price 25s. net.)

The object of this book is to teach the reader how to design a propeller for actual use. Little or no attempt is made to explain complicated theories regarding the subject, practical designing, and the best method of construction, being the chief aim of the author.

Chapter I. gives a statement of the problems involved viz., the designing of a propeller to run at a certain number of revolutions, the points to be considered when designing an efficient propeller, and the best method of designing one which is safe and reliable. The importance of correct design, owing to the greatly differing velocities of revolution and translation required for aircraft, is pointed out.

In *Chapter II.* the general terms and definitions used in propeller design are explained. It should be noted that the author, takes the "Geometrical Mean Pitch," to be the geometrical pitch of a section of the blade at a radius equal to two-thirds of the tip radius, while he defines the "Experimental Mean Pitch" as the distance which the propeller must travel along its axis, in the time taken for one revolution, in order to give no thrust.

Chapter III.—In this it is pointed out, that the blades of a propeller are really aerofoils; and the terms generally used in connection with surfaces of this kind are fully explained. The component re-actions, lift and drag, are discussed, as also changes due to the alteration of the angle of incidence, shape of the aerofoil, cross section, camber, etc., and the Vl effect pointed out by Lord Rayleigh. This latter effect is of great importance, as it governs the application of model tests to full sized design and work generally.

Chapter IV. gives an account of the "Simple Drzewiecki Theory" of the propeller. In this the blade is considered to be divided into a number of strips of aerofoil cross-section (so small that all points of a strip have the same velocity) the aerodynamic forces on which are assumed not to interfere with each other's action, and the total power etc., exerted by the propeller is calculated by a system of integration from that on each strip *unit.* The general expressions for torque, thrust, etc. are worked out, and their controlling factors discussed. Explanations of the change in engine revolutions with variation of speed in aircraft, the alterations caused by change of altitude in flight and other questions of importance are given and the chapter closes with a description of the method of measuring the propeller co-efficients under actual flying conditions. It is pointed out that the thrust

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co-efficient cannot be obtained from full-sized trials and that model tests in a wind tunnel are necessary to find it.

Chapter V. will be found particularly useful by students, as it gives an example viz.: the analysis of the two bladed propeller AB.7322 under certain given conditions; describes the application of the principles of Chapter IV. to the design of an actual propeller, and discusses the case of a design specified for an altitude.

Chapter VI.—In this the "Inflow" and "Outflow" of the air about a propeller are considered. The former is defined as the velocity of the air from the front which by the time it reaches the plane of rotation, is in excess of that of the surrounding air, while the latter is defined as the excess of velocity of the air affected by the propeller, over that of the surrounding air. An explanation of Froude's theory of the propeller follows and a comparison between it and that of Drzewiecki is made. It is pointed out that both are incomplete, as the former neglects the losses incurred by transforming a torque into a thrust, while the latter omits the inflow velocity of the air. It is further explained that by Froude's theory, the diameter of the propeller should be as large as possible, while by Drzewiecki's it should be as small as it can be conveniently made. The author considers, that Froude's theory is correct (within limits) but suggests that further examination of the subject from the scientific point of view is necessary. He further states that Froude's assumption that the flow of the air through a propeller is approximately stream line appears to be fully justified, and that a combination of the two theories is a reasonable proposition.

In *Chapter VII.* an attempt is made to connect the two theories and to compare the results obtained from the combination with the results of previous calculations. The different values of torque, thrust, etc. are shown by a new set of equations based upon the idea that the inflow velocity (a_1 V) and the rotational inflow velocity (a_2 V_1) are allowed for, and a general explanation of the system follows. It is pointed out that the rotational inflow velocity must be considered for tail plane and rudder designs, but that in ordinary cases it can be neglected. The author shows that the true efficiency is the product of the Froude and Drzewiecki efficiencies, except that the latter is calculated with the true velocity through the plane of the disc, and not the aircraft velocity. A useful analysis is given in an appendix to the chapter.

In *Chapter VIII.* the question of over-all efficiency is discussed: viz.: the efficiency of a propeller working in an aeroplane which may fly at any of the possible speeds, within its flying limits. The author describes the policy of design, especially in the case of war aircraft when climbing power is of great importance, and shows that the fundamental condition for any design of propeller is (under the given conditions) that it shall not allow the engine to exceed a certain number of revolutions, when that engine is running with a fully open throttle. A mathematical examination of the Primary and Secondary efficiencies (as defined by the author) follows, and the chapter concludes with a calculated example illustrating the ideas developed.

In *Chapter IX.* the flow of air through a propeller is further considered, and also the effect of placing a body in the air stream. As regards the

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air flow, it is shown that the air particles follow a spiral path and that this must be taken into consideration. A very full description of some model experiments carried out at the Nat. Physical Laboratory is given to illustrate this question.

The results of experiments on " Mutual Interference " between a propeller and the body of an aeroplane are given, and the reasons why the interference factor is so difficult to estimate are explained.

In *Chapter X.* formulæ for the calculation of the strength of a propeller are discussed and the various stresses to which a propeller is subjected to explained. Fully worked out examples are given, describing both the ordinary and approximate systems of calculation.

In *Chapter XI.* the question of gearing, and the relative advantages of four and two bladed propellers are considered. As regards gearing, the difficulty of estimating the advantages and disadvantages is pointed out, and the general conclusion arrived at is, that for high powered engines with crank speed of from 1800 to 2200 revolutions, gearing is essential, while for low powered engines about 100 HP, gearing is not worth while. As regards four and two bladed propellers, the points for and against each type are summarised and the general conclusion arrived at is, that as a rule the two bladed type is the more efficient, but that the four bladed propeller has certain advantages, such as smoother running and less wear and tear of the engine parts.

Chapter XII.—In this " Tandem propellers " viz. : two propellers working one behind the other are considered. Expressions for Torque, Thrust, etc. are given and the author states that, in practice, it would appear advisable to use the largest possible two bladed propeller in front and the largest possible four bladed propeller in rear, subject to the latter being completely immersed in the slip stream of the former. The subject however requires further investigation as the experiments so far carried out are not at all conclusive.

In *Chapter XIII.* the " variable pitch " propeller is discussed, as also the type of propeller having a variable surface, and the difficulties of designing the latter are pointed out. It is explained that while such propellers have certain advantages they have three great disadvantages, viz. : they give extra work to the pilot, additional control is required and the design and manufacture of the propeller itself is further complicated.

Chapter XIV.—In this the " Hub " is considered and the difficulties met with in transmitting the torque from the propeller shaft to the propeller are explained. The various practical methods of doing this are described.

In *Chapter XV.* the principle of the Windmill is explained, as it is of some importance, on account of its use for transmitting power to the pumps, and generating sets for wireless etc., on an aeroplane.

There are three Appendixes—No. 2 is an interesting " Handbook on the Construction of Propellers."

The book is very well and clearly illustrated.

J. D. FULLERTON, *Colonel, R.E. (ret.)*

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NOTICES OF MAGAZINES.

THE MILITÄR-WOCHENBLATT.

No. 73.—*The Kraewel Brigade on the 8th and 9th Sept.* 1914.—General Von Kraewel, describes how he, the commander of the 34th Infantry Brigade, was also in command of the main body of the 17th Division, which, early in the morning of the 8th Sept. 1914, had resumed its withdrawal from Montmirail northwards through Chateau-Thierry. At noon, a long halt was made and at 1.45 p.m., while halfway between Mouthiers and Bonnes, he received an order, timed 1.10 p.m., from Von Quast, his Corps Commander, to the effect that 3 hostile columns were advancing northwards between Rebais and Coulommiers, that he was to destroy the bridges and hold the line of the Marne from La Ferté-sous-Jouarre to Nogent, both inclusive, while 3 cavalry divisions held the Petit Morin, and that he was to have 2 Regiments of Infantry, 2 Brigades of Artillery and 1 pioneer company to do it with. The order was, naturally, a considerable surprise to Von Kraewel, also the only map that could be found covering the section of the Marne to be held was a $\frac{1}{300000}$ cut out of a newspaper which an officer happened to have. By good luck the rendezvous, Montreuil-aux-Lions was marked on it. Kraewel collected his infantry and artillery there without mishap, but only by very strenuous marching; the pioneer company never turned up at all. He then decided that he could not hold the actual line of the Marne. It was 7 o'clock, and would soon be dark; the country was intricate and quite strange and he had no maps; his infantry was very tired, and the deep windings of the river rendered it very difficult to hold. He decided to hold the high ground, north of the river, round about Montreuil-aux-Lions and disposed his force on a front of about 5000 yards in such a position that any hostile advance beyond the river would involve a stand-up fight with his whole brigade, firmly established in their chosen position. The destruction of the Marne bridges had to be abandoned owing to the non-arrival of his pioneer company. The night of the 8–9th passed quietly, but at 7.45 a.m. on the 9th British artillery fire opened on some cavalry baggage wagons parked near Porte Ferrée, and soon after the Infantry battle began. At 11.30 a.m., while hotly engaged, Kraewel received orders to co-operate in an attack on the enemy advancing on Chamigny. He replied that it couldn't be done at the moment. The artillery fire increased and he received word that two jäger battalions were coming to help his right flank. These however never got into touch with the Brigade H.Q. At 2.0 p.m. it really looked as if the British were going to rise to the assault. At 2.35 p.m. word came that the 5th Division

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was coming to reinforce him and he had hopes of himself being able to attack. Hostile cavalry, advancing through Charly on Villiers, he left to be dealt with by the 5th Cav. Div. which lay, however, rather far back at Marigny. One of his regiments reported it could not hold on much longer; he replied that it must and that the 5th Inf. Div. was coming to help; at the same time he again received orders to attack, but replied that he could not do so till 5th Inf. Div. arrived. Corps H.Q. probably thought this division much further advanced than it really was. At 3 p.m. an Officer of the 19th Cav. Bde. reported that his brigade wanted to attack the rear of the British who were pressing Von Kraewel's right flank. This attack never materialised.

No. 74.—At 3.15 p.m. on the 9th the infantry fighting died down somewhat, but the left flank reported constant attempts were being made to out-flank them, and La Loge was for a time seized by the British, who were, however, shelled out of it. Hostile columns were seen near Bezu but at the same time the head of the long awaited 5th Inf. Div. was reported as having reached half way between Vendrest and Dhuisy. At 4.0 p.m. the situation appeared brighter and the 5th Inf. Div. were nearing Montreuil. It looked as if the time to counter-attack was approaching, but at 6.30 p.m. two things happened. First the British were reported in Marigny, 3½ kilometres N.N.E. of Bde. H.Q. at Ferme l'Hopital, and therefore right behind the brigade, and, secondly, the approaching 5th Div. was seen to stop, assemble and march off towards the north. Shortly after came word that the 9th Cav. Div. was going back to Cocherel, and touch with the 5th Cav. Div., which should have been near Marigny, was lost. The situation was grave; deserted by his neighbours, with both flanks in the air and, in deed, probably surrounded on 3 sides, the Brigade was without orders. Von Kraewel determined to fight on where he was, and to tell his troops nothing of their dangerous situation. At last came an order from the Cav. Corps Commander, Von der Marwitz, under whom he had been placed, to break off the fight and join the 5th Inf. Div. at Gandelu. With considerable skill Von Kraewel slipped out of his position about 8.0 p.m., being obliged however to leave behind him the guns of one battery, which the Infantry tried, without success, to save. The column passed only 2½ kilometres west of Marigny and had a long halt at Prémont 4 kilometres north-west of this village, but was undisturbed by the British. Eventually about midnight 9–10th Sept., it reached Gandelu, where it lay, as its commander says "like dead men," on the road till 5.0 a.m., 10th, waiting for the roads in front of it to clear. By the 12th Sept. it was north of the Aisne, having crossed at Venizel, and in position west of Vailly. Von Kraewel claims that already on the 10th Sept. his men were fit to fight again, and, especially if the masses of cavalry had been used dismounted to help him, could once more have checked the British advance. He says the British tactics were unskilful, but forgets that we were probably even more exhausted with marching than he was. He claims complete success and says that even if he, the 5th Inf. Div. and the Cav. Corps had been completely wiped out, success from the point of view of the 1st Army could still have been claimed. He makes very small mention of the failure to demolish all

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the bridges over the Marne, merely hinting that, as he had not got his pioneers, the Cavalry Divisions might better have undertaken this. Possibly if he had told them on the night of the 8–9th how he was situated in this respect, they would have had a try at it, though it is doubtful whether they had, by then, either the time or the material to accomplish much. However that may be it was certainly an agreeable surprise to the British Sappers to find any bridges intact.

Compulsory retirement of active list Officers consequent on the reduction of the Army.—The writer points out how badly treated as regards pensions officers are, compared with officials. He advocates the formation of an officers' union, as the only way in which officers can get their case justly dealt with. Three Situations in Municapilities are offered to ex-officers. Pay from 3000 to 9000 marks per annum.

Roll of Honour Infantry Regt. No. 16—103 Officers and 2871 other ranks killed. Of the Officers, 45 fell in the first 7 months of the war, and 15 at Neuve Chapelle.

No. 75.—*The Fall of Antwerp*, by Gen. Von Zwehl, describes the capture of the city, early in October 1914. The despatch of a British Contingent to help in its defence is discussed and Lord French's opposition to the measure approved. The extent of the Belgian training camps of Beverloo and Braschaet, stated to be considerably in excess of the requirements of the Belgian Army, the design of the buildings, which is said to have been in British *Geschmack* and the presence of British-made instruments in the well-equipped Hospitals of the Fortress, are held to prove that some agreement, to give assistance, had been made by the British Government. Great Britain therefore felt bound to give some, even if only limited, help, which however did not affect the fate of the city.

The bombardment destroyed or damaged about 800 houses in the city and 500 in the suburbs. The greatest efforts are said to have been made to spare the architectural treasures of the place. The demolitions carried out by the Belgians to clear the field of fire of the inner line of forts are deplored, as they were executed in consequence of obsolete defensive principles. The inner line of forts was never defended.

Strength of the German Army.—The distribution of the 200,000 men allowed by the peace treaty as the strength of the German Army is given as follows :

44 Infantry Regts. of 3 Battns. each.	21 Mech. Transport Dets.
23 Cavalry ,,	19 Brigade Bridging trains.
20 Artillery ,,	18 Sanitary Companies.
21 Battalions Pioneers.	20 Headquarter Formations.
29 Communication detachments.	76 Field trains.

No. 76.—*The Fall of Antwerp* (*concluded*) by General Von Zwehl, describes the negotiations for the surrender of the city. The Civic authorities proceeded on their own initiative to the German G.H.Q. at the same time as the latter sent an officer into the town to demand its surrender. They did not meet on the road and Von Beseler refused at first to negotiate ; the bombardment was however suspended and

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eventually the German officer returned with a report that the city was no longer defended. Terms of surrender were then dictated and hostages taken. An order by the Belgian Commander, who was captured in one of the forts, to the effect that any persons approaching the Fortress as " Parlementaires " were to be fired on, was discovered. For this, though it admittedly was cancelled almost as soon as issued, the Germans brought him to trial. The proceedings were however dropped " We Germans are not very vindictive in such matters " ! The writer discusses the point as to whether, in view of the comparatively small numbers of prisoners taken (about 5000), it might not have been better to attack from the west and south-west, instead of from the south and south-east. He concludes that, as it was so urgently necessary to remove the threat of the Fortress from the German flank and rear, as the conditions of the ground in the former direction were very unfavourable and as the assailants were in such small numbers compared to the size of their task, the course chosen was the wisest, even if it did allow the bulk of the garrison to escape.

Anti-tank weapons—a defence of the German Authorities against charges of having failed to provide adequate anti-tank weapons in time. The familiar anti-tank rifle, of which 4000 were issued between March and August 1918, weighed 35 lbs. and its steel cored 0·52″ bullet would penetrate at 550 yards 0·8″ of best steel plate. Every pair of anti-tank rifles had a hand cart for them and their ammunition. The Germans had intended to introduce a 0·52″ anti-tank machine-gun and a 1·48″ gun in the spring of 1918, but for some reason not stated, found this impracticable until October 1918 ; in fact they were never used. The writer thinks they would have stiffened the German defence.

Names of Commanders.—The names of the Brigade, Regimental, and Battalion Commanders in the New Army are given, together with their pre-war appointments. Each Regiment is designated as " Reichswehr Regiment No —" and the Brigades as " Reichswehr Brigade No. —" without any territorial or other qualification.

My Report on the Battle of the Marne (1914) by Field Marshal Von Bülow is reviewed at length. The reviewer, referring to the battle as the turning point of the war, says that Von Bülow's order to retire was quite right from his appreciation of the situation of the 1st, 2nd and 3rd German Armies, and that he could not forsee the fateful effect his order would have on the whole campaign. The Supreme German Command failed to give any decision, and it is questioned if Von Moltke was equal to his task. He installed his Headquarters too far away, adequately to control operations under the then undeveloped condition of the communications, but too near Alsace Lorraine, and lost his sense of proportion in consequence. The result was that troops for the East Prussian Campaign were taken from the right wing of the German Army and not from the really comparatively unimportant left wing. Joffre did better. Von Bülow makes it quite clear that the decision to retire was his and his alone, and emphasises his difficulty and reluctance in so deciding, when, so far, he had led his troops to nothing but victory after victory.

With Lettow-Vorbeck through Africa by Dr. L. Deppe, is one of many

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German books now appearing on this campaign. The Author is confident that this beautiful colony is not passing for ever out of German hands.

No. 77.—*The leading article*, in reviewing the military and political events of 1919, says that it was nothing but the support of the officers which upheld the government in the early part of the year when civil war raged. It exhorts all officers to do the same again if necessary, however unworthy the government may be and however ungrateful and abusive certain strata of society. Prince Max of Baden is blamed for the collapse of the "Undefeated" German Army, but the Navy comes in for the hardest words. It is despised by friend and foe alike. Abuse of Germany's enemies and sympathy with the even more hardly treated Austria follows and the writer concludes with an appeal to all officers to raise again the high pre-war standard of work and devotion to duty among the officers, so as to ensure that Germany's Army, even if small, is of the best possible quality.

Soviet-Russia, an account of the recent events in Russia, says that at the end of 1919, Bolshevism stands stronger than ever, thanks to the short-sighted, selfish, etc., etc., policy of the Entente. "Lord" Churchill's speeches pointing out the danger, are quoted with appreciation, and the downfall of Bermondt and Von der Goltz, which has rendered it by no means certain that Bolshevism will stop at the Baltic States, is attributed to British intrigue.

French Phantasies is the heading of quotations from French papers about the "Secret German Army."

Roll of Honour—Infantry Regiment No. 26—A supplementary list of 8 Officers killed.

L. CHENEVIX-TRENCH, *Major, R.E.*

REVUE MILITAIRE SUISSE.

No. 11.—*November*, 1919.

THE FIRST BATTLE OF THE MARNE.

Lieut. Colonel Poudret, the author of the original article, tells us that by degrees Germany is being enlightened as to the true facts of the First Battle of the Marne. For many months after the defeat of the Kaiser's hosts, the public of the Central Empires had been led to believe that the Battle was merely an affair entered into incautiously by the German A.G., and that the small bodies of German troops, which had crossed to the S. of the Marne, on coming into contact with superior forces, had succeeded in retiring without suffering serious loss. A long silence ensued in relation to the details of the struggle on the river: it had been hoped by the German leaders that in the event of a successful issue of the war, this ugly reverse would have been readily forgotten in the Fatherland. But the authorities failed to reckon with those of an inquisitive turn of mind, with those who were discontented with the conduct of affairs and with those who were well informed on the situation.

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When the War was found to be dragging on, the significance of this initial check came to be duly appreciated in Germany, and the anger of the public against those who were guilty of deceiving them grew to serious proportions. A scape-goat was wanted: and to this fact was it due that an attempt was made to explain matters. Then von Moltke was removed from his position and died shortly afterwards; von Kluck was also attacked, and attempted a defence of himself. Later, it was the III Army, the Saxon Army, which was held partly responsible for the disaster; and this it is that has caused General Baumgarten-Crusius to publish his *Die Marneschlacht*, 1914, a work founded on official documents.

The III Army has also been violently criticised for the part it played at the Battle of Mons; it has been reproached in respect of its late arrival on the Meuse (*vide* Hanotaux's *L'Enigme de Charleroi*). It had been intended that, in the operations on the Meuse and the Sambre, the III Army should constitute the "surprise element." It was to this Army that the task had been allotted of cutting the communications of the French Army or Armies, which the Great General Staff had hoped to have lured on to Namur. The caution of Marshal Joffre prevented the Saxons from scoring; only the 5th French Army advanced as far north as the Sambre. General Baumgarten discloses the vexation experienced in the German Camp at this failure to bring off a big *coup*; he accuses the French of having deserted their Allies, who are said to have, in consequence, abandoned their plans. "*The dream,*" he says, "*of a joint invasion of the Rhine provinces vanished away.*" It can well be understood that the Saxon Army is not willing to accept responsibility for the miscarriage of the German plans: in the early phases of the War and during the Battle of the Marne, this Army found itself in an extremely delicate position.

The III Army had, moreover, from the very beginning been much weakened. Its XI A.C. had been withdrawn first for the investment of Namur and was later sent to Russia. Its Cavalry Division had also been despatched to the Eastern Front, and no mounted troops were allotted to replace it, in spite of repeated representations on the subject. Being sandwiched between the II Army on its right and the IV Army on its left, the Saxon Army was being continuously, and with great insistence, called upon for assistance by its neighbours, but often without justification. In consequence, its troops were frequently unnecessarily scattered to the right and left.

At this period, von Kluck was under the orders of von Bülow, G.O.C. II Army; the subordination of one Army Commander to another produced unfortunate results. On the other hand, the III Army received its *directives* from the German G.H.Q.; but since the G.H.Q. was located at a considerable distance in rear of the battle front, it was not possible for it to keep in touch with the rapidly changing events where troops were in contact. In order to bring off the encircling movement planned by the Great General Staff with success, it was essential for the Germans to have arranged for unity of command in respect of the three Armies to whom had been assigned this important task. It was necessary that the movements of these Armies should be regulated with that *Gründlichkeit* for which Germany was renowned and of which

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she made a boast. Instead, von Bülow attacked on the 21st August, a date too early to suit the arrangements of von Hausen and before the Saxons were ready. The earliest date by which the III Army could be ready was the 23rd *idem*; the XII A.C. which was to replace the XI A.C. was too far in rear to admit of its being employed effectively earlier than on the date last mentioned. Moreover, at this time the III Army could have been more advantageously employed in the region of Givet, and to that locality it should have been sent instead of being held on a narrow front at Dinant. The Great General Staff was really responsible for this failure in the co-ordination of the German effort on the Western Front.

The German II Army realised that it could not successfully cope single-handed with the situation on the Sambre. It was expected that von Hausen would lend support by advancing his right wing towards Mettet; at the same time the III Army was wanted in the South. The German Staff hesitated, orders and counter-orders were issued, and this resulted in producing confusion.

When von Hausen did finally attack on the 23rd *idem* on the Meuse, it was the magnificent defence of the French which took the Germans by surprise. In spite of the cannonade of the 57 German batteries aligned on the front Yvoir-Blaimont, in spite of the mass attacks of the Saxon infantry, the French held on to their positions until the evening of the date last mentioned and only retired when so ordered to do. This stubborn resistance upset General Baumgarten's plans. In his report to the German G.H.Q. the Commander of the III Army attributes the delay which took place in crossing the Meuse, and then only by weak detachments of his Army, to the difficulties of the *terrain* and to the presence of a *great body of franc-tireurs*!

However, the real defence of the Saxons contained in General Baumgarten's volume rests on grounds other than those mentioned above; grounds which are more substantial and supported by more convincing arguments. Thus at 4 a.m. on the 24th *idem*, when von Hausen wished to continue his march in a S.W. direction, having persuaded himself that von Bülow was in a position to deal unaided with the French 5th Army, a *liaison* officer of the II Army arrived on the scene and stated that on the previous day 5 French A.C. had been engaged and that whilst, on the whole, the German attack had progressed favourably, nevertheless it was absolutely necessary for the III Army to co-operate in an E. to W. direction during the continuance of the offensive ordered for the 24th *idem*. Von Hausen once more renounced the intention of marching S. and issued counter-orders. But Lanrezac was already in retreat on the evening of the 23rd *idem*. Another change in German plans took place at 9.45 a.m. on the 24th *idem*. The II Army had at last correctly appreciated the situation: von Hausen had now a free hand and began to march to the S., his right wing being directed on Mariemburg and his left on Revin-Rocroi. However, he was too late. The skilfulness with which Lanrezac directed his retreat, which was well timed; the splendid handling of the French 1st A.C. and the tenacious fight put up up by the 51st Reserve Division helped to ward off the pressing danger.

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General Baumgarten expresses the opinion that the Germans would, to a certainty, have succeeded had weak detachments been sent towards Dinant; had the III Army been directed on Givet-Rocroi on the 20th *idem*; and had a strong cavalry force been employed to close the gap S. of Maubeuge on or about the 25th *idem*. He attributes blame for the German check on the German Higher Command.

Colonel Poudret points out that there is, however, one mistake in respect of which the blame cannot fall on the German Higher Command, namely that connected with the despatch on the 23rd *idem*, in all haste, of an improvised Division on Givet to which the task was assigned of pursuing the enemy along the left bank of the Meuse. This Division was sent off *without bridging equipment*; it came into contact with the enemy on the same evening, near Willerzie and met with obstinate resistance. As might well have been expected, this Division found the bridge at Fumay destroyed; it implored the IV Army to assist it with the loan of bridging material, but was not able to obtain the same. The Division next sought to cross the river at Revin, but here also the bridge had been destroyed. It was not till the 26th *idem* that this Division crossed the river, and it was only on the 27th *idem* that it was able to rejoin its A.C. (the XIX), after three days of useless marches and engagements.

The Saxon Army continued during the whole of the interval between the Battle of Mons and the Battle of the Marne to play its thankless rôle, first assisting one of the neighbouring Armies and then the other. Colonel Poudret describes the perplexing nature of the demands made upon von Hausen. Finally, on the 28th August, in view of the general situation, the German Armies were formed on a front which caused their further advance definitely to take a S.W. direction. Paris was included in the zone of action assigned to the German I Army, whilst the II Army was echelloned further to the W. The dispositions of the French Armies and their retreat caused the German Armies to advance more directly to the S.; the German right Wing was drawn to the E. of Paris, owing to the precipitate action of von Kluck, who, failing to appreciate the dangers lurking on his right, resolved to reach the Seine, at all costs, at the same time as von Bülow. That is to say, von Kluck abandoned the direction and the sector assigned to his Army. The want of firmness of the German Higher Command during these decisive days is striking. Moltke saw his orders flouted by the Army Commanders, who acted too hastily and assumed too much independence.

In the orders issued on the 28th August by the German G.H.Q., the VI and VII Armies were directed in the first place to oppose a French advance into Lorraine and Upper Alsace. On the other hand, should the French retire the VI Army (and the 3rd Cavalry Corps) was under orders to cross the Moselle between Toul and Epinal and march on Neuchateau: this Army constituted the left flank guard of the German Armies. The VII Army was to remain in subordination to the G.O.C. VI Army, until the latter Army had crossed the river, when it was to take on the independent mission of opposing the French should they advance between Epinal and the Swiss frontier. The Germans did not, it will be seen, renounce the operations planned for their left wing, in spite of the loss of the battle for the Charmes Gap, which had just ended. To

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this retention of troops in this region must to some extent be attributed the reverse which the Germans met with on the Marne.

The III Army continued to be distracted by contradictory orders. On the 29th *idem*, not only was the IV Army appealing to it for help, but also the II Army—von Bülow was at the time fighting the Battle of Guise. On this occasion, von Hausen turned a deaf ear to these calls for assistance and stood by the Duke of Wurtemberg's Army. The Saxon Army continued to be faced with difficulties of various kinds up to the Battle of the Marne, and even during this Battle. The German G.H.Q. did not intervene once to help the III Army in the predicament in which it was thus placed; it did not even fix any line of demarcation between the III and IV Armies, and, in consequence, much friction occurred. Again, in the orders issued, the task of capturing Hirson was assigned to the III Army, but when it arrived there the fort was already in the hands of the II Army: von Hausen had received no intimation in the change of plans.

The orders issued by the German G.H.Q. continued to be faulty up to the eve of the Battle of the Marne. On the 3rd September, the I and II Armies were duly informed of the intentions of the Great General Staff, but the III Army was left entirely in the dark.

The Germans however changed their plans. Having learnt that in their retirement the French had left Paris somewhat at a distance on their left, the question arose of cutting the French off from their Capital and rolling them back in a S.E. direction. The Germans seemed to have been blind to the menace of Paris and of Maunoury's Army; von Kluck thought only to ensure the arrival of his Army on the Seine according to his own plans and advanced towards the river by forced marches. The situation thus became one in which the Great General Staff exercised less and less control. The orders issued on the 5th September indicate that the Great General Staff had lost touch with the situation: these orders are quoted in the original text:—

"His Majesty orders:

"The I and II Armies to remain facing Paris on the E. ready to act "offensively against any enemy forces which may issue from the "fortress. 1. The I Army is assigned to the sector between the *Oise and* "*Marne*; the II Army to the sector between the Marne and Seine. The "2nd Cavalry Corps to act with the I Army and the 1st Cavalry Corps "with the II Army; 2. The III Army to advance on Troyes-Vendeuvres; "3. The IV and V Armies to open a passage on the Upper Moselle for "the VI and VII Armies by advancing, without a halt, in a S.E. direc-"tion; the Right wing of the IV Army by Vitry, and the right wing "of the V Army by Revigny. The 4th Cavalry Corps to reconnoitre "in front of the IV and V Armies; 4. The missions of the VI and VII "Armies to remain unchanged."

Thus, whilst von Kluck was already on the evening of the 5th September on the Grand Morin, his Army was assigned to the sector between the Oise and Marne! This shows clearly enough how completely the German Higher Command had lost touch with the actual situation.

The Battle of the Marne had scarcely begun before von Hausen found himself being appealed to for assistance and even for advice. In con-

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sequence, the III Army was strung out on too extended a front, its right wing was fighting with the Guards Corps under von Bulow, its left wing, the XIX A.C., with the right wing of the Duke of Wurtemberg's Army (the VIII A.C.). It was as much as von Hausen could do to close the gaps caused by the badly co-ordinated plans of the German Commanders : he could in no way take advantage of the situation created by the gap in the French line between Sompuis and la Maurienne, opposite his front.

Colonel Poudret shows how it was that the Saxon Army became dispersed soon after the great Battle on the Marne began.

During the titanic struggle, which continued for five long days, the III Army had made considerable progress : just before the German retreat began, its right had passed beyond la Maurienne, its centre was S. of Mailly, whilst its left wing was held up on the line Sompuis-Huiron.

At this time, General Foch's position appeared to be seriously compromised, not that he was willing so to admit : his optimism, as events turned out, was fully justified. Since the early morning of the 9th September sinister rumours had been reaching the H.Q. of the III Army : at 7.45 a.m. a wireless message was received from an unknown source, probably German G.H.Q., indicating that things were far from going well. The message stated that the II Army had withdrawn its right wing to Marigny : at 1 p.m. a further message arrived showing the seriousness of the situation. The last message ran as follows : " The II Army in retreat, right wing Damery."

The game was lost. Von Hausen nevertheless was able to report : " We have taken Euvy." However, at 2.15 p.m. the Staff of the III Army found it necessary to issue orders for a retreat and to make preparations for recrossing the Marne. At 5.30 p.m. further confirmation was received concerning von Bülow's retreat and also of the fact that the I Army too was retiring. As it was during the Battle of the Marne, so in the retreat from that river, the III Army was separated into two groups : the XIX A.C. continued to co-operate with the IV Army, whilst the XII A.C. acted practically under the orders of the G.O.C. II Army.

If from a tactical point of view, the German retreat was conducted in good order, it was not so from a strategical point of view. The German Higher Command did not at all times have a grip on the situation. The III Army received orders for the 10th September directing it to be ready to resume the offensive to the S. of Chalons ; had it been so employed it ran the danger of being isolated S. of the Marne, for the II Army was retiring. The latter Army called to the III Army for help, but von Hausen seems to have had enough of this sort of thing and replied : " Please do not uncover the flank of the III Army."

The III Army again had to choose between the " directives " of the Higher Command and von Bülow's cries for assistance : it did not know what to do. Von Hausen decided to remain S. of the Marne and called on von Bülow to allow the rear-guard of the Guards Corps to cover his threatened flank. However, von Hausen was not long able to maintain his Army in this region single handed. Fortunately, an order arrived at 5 p.m. from the German G.H.Q., instructing von Hausen to conform to the movements of the II Army, then retreating on to the line

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Mourmelon-le-Petit—Francheville, to dig in there and hold on. The retreat of the Saxon Army from the S. of the Marne was carried out during the night of the 10/11 September and on the 11th *idem*. Von Hausen left Chalons at 4 a.m. on the last-mentioned date for Suippes, where von Moltke was awaiting him. The presence of the Chief of the Great General Staff did not put a stop to the issue of counter-orders. The Saxons had scarcely begun to throw up entrenchments on the line indicated to them, when the plans were once more changed. Von Moltke had, in going to Suippes, passed the II Army and this resulted in the orders to the III Army being modified: it was now ordered to dig in on the line Thuizy-Suippes.

On the 12th September, von Bülow retired his left wing and invited von Hausen to carry his front to the N. of the line Prosne-Auberive-Souain. The Saxon Army Commander refused to do so, but at 7 p.m. an officer from the German G.H.Q. arrived on the scene and insisted upon von Bülow's request being complied with: this order was carried out. On the 13th September, von Hausen gave up his Command and was replaced by von Einem.

During this first phase of the Great War, thanks to the weakness of the German Higher Command, the Saxons had had to play a thankless rôle and had been unable to show what they were capable of. Colonel Poudret is of opinion that, to some extent, von Hausen was to blame for the state of affairs which prevailed: had he acted with greater firmness, he might have prevented the continual splitting up of his Army. He ought, it is said, to have also limited the initiative of his subordinate Commanders. Had he done so he might have been in a position to operate effectively against the right flank of Foch's Army opposite the Mailly Gap.

W. A. J. O'MEARA.

RIVISTA DI ARTIGLIERIA E GENIO.

Nov.—Dec. 1919.

THE SINKING OF THE "VIRIBUS UNITIS."

The authors of the last tragedy of the Austrian marine were two Italian Officers, Major of Naval Engineers Rosetti and Medical Sub-lieutenant Paolucci. Independently one of the other they had proposed to penetrate alone into the port of Pola and to reach one of the enemy's ships at its anchorage. Rosetti had been at work for a long time preparing a special machine for the expedition. The young Medical Officer had invented no machine, but proposed to swim, pushing a kind of mine before him, and anticipated a long immersion at night in the cold water of the lagoon.

Rosetti's apparatus consisted of a type of torpedo with two detachable mines in the front part, each containing about 160 kg. of trotyl. In the back part there was a motor worked by compressed air, which was

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stored at high pressure in a tank, with capacity sufficient to drive the mechanism for some hours at a slow speed. The mines could be readily fixed at any required depth to the bottom of a ship and a clock mechanism regulated the moment of explosion. The apparatus could carry two men, who rode astride on it and guided it with their hands in the water. It was decided that the two officers should work together, and after two months of hard labour, during which they learnt to overcome obstacles of every kind, they were ready for their hazardous adventure.

At 10.0 p.m. on 31st October, 1918, Rossetti and Paolucci descended from a M.A.S. which brought them within 400 metres of the outer defences of Pola. They were clothed in light water proof clothing, which covered their heads, leaving only their eyes free, and was fitted with air chambers on back and breast, and coated with a preparation of camphor to increase its resistance to the water.

Between 10.30 p.m. and 3.0 a.m. after great efforts the two officers succeeded in passing the outer defences and two strong and complicated interior booms. They passed close to the guard battleships and the sentries without being seen, driving their machine against the tide and helping themselves forward with their hands. Finally they came to the dark masses of the enemy's ships of the line, and with their tank nearly exhausted they pushed forward to the far end of the line deciding to attach their mines to the Admiral's ship. They had to go very slowly lest the phosphorescence of the water disturbed by their little screw should attract the notice of a sentry.

A little before 5.0 a.m. they found themselves less than 40 metres from the *Viribus Unitis*. Rossetti detached one of the mines and fixed it to the side of the ship. This took about half-an-hour, and meanwhile Paolucci waited at a little distance, doing his best to prevent the apparatus from striking against other ships. At 5.30, as dawn was breaking, Rossetti rejoined his companion, having adjusted his mine to explode at 6.30.

Just then the alarm was sounded and the two officers were seen from the doomed ship. Hastily opening the immersion valves of their torpedo and setting the mechanism of the second mine, they started the motor and jumped into the water and were captured. The second torpedo exploded against the great transatlantic steamer Wein, which subsequently sank.

Brought before the commander of the Admiral's ship the officers were informed that the fleet belonged to the Jugo-Slavs, as the Austrian Admiral had disembarked a few hours previously and all the crew who were not Jugo-Slavs had also left the ship. " If that is so " said Rossetti " I have to inform you that the *Viribus* will be blown into the air, and it is best to send away the men immediately."

These words spoken with much seriousness convinced the Commander Vukovitch, who gave orders to abandon the ship, allowing the two Italian Officers to be placed in safety. They tried to escape by leaping into the water, but were quickly recaptured by a number of excited sailors, who wanted to imprison them in the lower parts of the ship. While this was being discussed, at 6.30, a violent explosion shook the

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battle-ship. The sailors fled and Rossetti and Paolucci were able to leave the *Viribus Unitis* for the second and last time. She began to sink and a few moments later capsized. The commander Vukovitch met his death bravely at his post, his skull fractured by a great beam as the ship sank.

The two officers remained prisoners-of-war for a few days, when to their joy they saw Italian war ships entering the port.

Had the war continued other plans were in course of preparation to strike another serious blow against the Austrian battle squadron. But the enemy's army, which only four months before had been promised the free sacking of the plains of the Piave, was dispersed beyond the Alps, suffering terrible losses.

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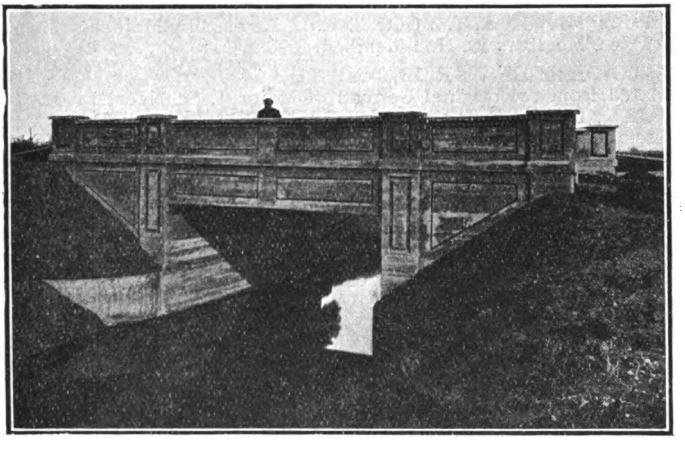

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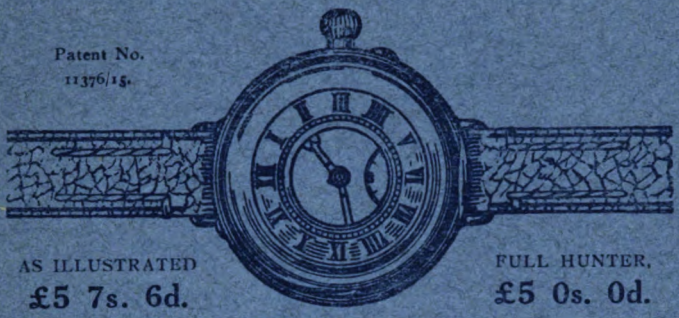

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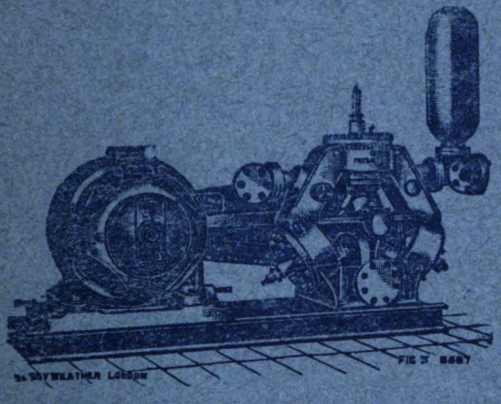

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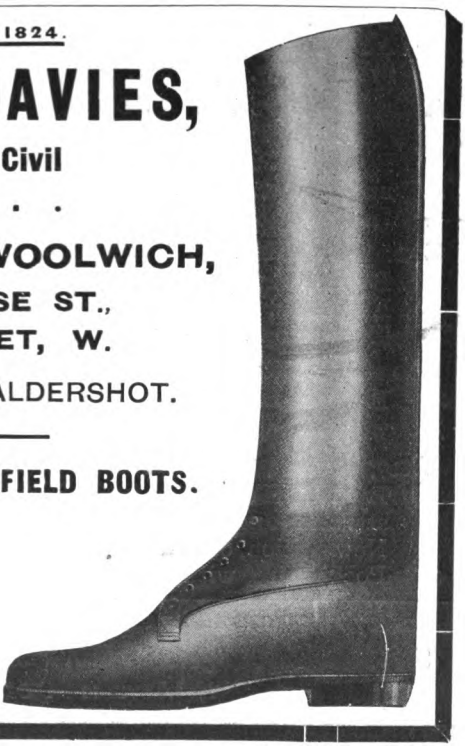

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2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography, or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

3. The name of the recipient of the Prize shall be notified in the Corps publications; and copies of the contribution for which the Prize was awarded shall be presented to the representatives of the donors.

The following are suggested as subjects for contributions:—

(*a*). Descriptions of works actually carried out in peace or war.
(*b*). Inventions.
(*c*). Design (excluding works of defence).
(*d*). Labour organization on work.
(*e*). Scientific investigations generally.
(*f*). Accounts of exploration work and surveys.

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CAMOUFLAGE VERSUS CAMERA.

By MAJOR G. MACLEOD ROSS, M.C., B. ENG., LATELY O.C. 227TH FIELD CO. R.E., B.E.F., FRANCE.

IN April, 1918, when Germany was making her final effort to break through to the Channel Ports, it became necessary to construct additional defensive positions on the Second Army Front. These were multiplied unceasingly—a large amount of concrete, both mass and in blocks (both reinforced), was put in, and large lengths were revetted.

Each system consisted of 3 lines connected by communication trenches:—An outpost line, where the main force of the attack would be broken, and which would ensure employment of enemy reserves at the earliest possible moment; a support line, close up, but, as far as possible, providing good shelter from shell fire, in which were housed our close reserves, and a reserve line, 600 to 1000 yards in rear, where Divisional reserves could be deployed under cover. The lines were conceived solely for a one-day battle, hence their multiplicity. This fact should be borne in mind when criticizing the following efforts to bluff the enemy.

It was never expected that the devices employed would stand the wear and tear of a drawn out battle, much less "trench" warfare in the accepted sense. The sole idea was to inflict maximum loss on the first day's attack; to break up quickly a large and highly organized attack and so gain time. If success was achieved, all cunning would have to be cut out and the old tactics resumed. The deception would have then justified the highly skilled labour and extra time employed on it. To-day, so many things are called camouflage that it may be interesting to examine the "invisible" trench described below, which, I submit, is an example of real camouflage. Efforts have been made with painted canvas, etc., to conceal the position of a trench, but never successfully. For real camouflage over a large area reliance cannot be placed on any artificial aids such as canvas or paint. The trench in question was unfortunately never tested by war, but I venture to express the opinion that it would have justified our hopes.

Now, hiding an object in war is really only one half of the problem, the other half is supplying the enemy with something else to play with. The enemy in the late war had well-known characteristics. If you puzzled him he lost his temper and got "windy" at once. If you

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even apparently began to spread your cards on the table, he waited until you had, as he thought, fully developed your idea. We thus arrive at a system known as "multiplication of objects."

The country in which the work was done was, save for a few bomb holes, untouched by war. The ground was under cultivation by the farmers, and glancing at an aeroplane photograph of the district, we find that save for villages here and there, we have a very regular chess-board effect. This was constantly changing its texture as the corn and other crops matured, and were finally harvested. Nevertheless the different crops, whatever their condition, still retained their own characteristics.

It was study of the aeroplane photograph which suggested the utilization of the drains or junction lines of the various plots for the course to be taken by the trench itself. This, and the fact that it was easier to hide a straight trench than a traversed trench, as employed to date. All the same, traversing the "invisible" trench had to be dealt with. This was overcome by arranging to cross and recross a plot or to "step back" on a series of plots.

Fig. 1 shows the ground taken from some 5,000 feet. It will possibly be simpler to follow if I proceed to enunciate the proposition in this particular instance. A communication trench dug to depth ended at Pt. A. Along C.D.E.F. ran the reserve line of the position.

Required to (1) proceed from A to D by an invisible path and (2) to provide between A to C a blind on which the enemy could focus all his attention. Possibly I should explain that "invisible" means invisible on aeroplane photographs taken at 13,000 feet and upwards by enemy 'planes.

Requirement (1) was fulfilled by digging a trench 3 feet wide, 3 feet deep and 2 feet wide at bottom along the line shown from A to D (in white.)

Requirement (2) by digging a dummy trench from A to C. The enemy plane would come over, take his photograph and read it incorrectly. He would not notice the real trench, but only the dummy which cries out to heaven, consequently this would be shelled.

I may quote here the Intelligence Officer, R.A.F., in conjunction with whom this work was carried out:—"Direct observation "from the air is of little value so far as trenches are concerned. "From a high altitude the observer is distracted by a vast range "of view, and, even supposing he did spot the trenches he could "not make out sufficient detail to determine whether the trenches "were dummy or real—the observer flying low passes over objects "too quickly to give any one object more than a few seconds' "attention. The camera is the real enemy. Photographs taken "low show good detail and the objects are large, therefore "interpretation is comparatively easy . . . . the enemy would

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" plot them on his maps and would have every reason to believe " that they would be occupied, so that his fire would be directed " on them. Any attack by the enemy on such a trench system " would result in disaster for the attackers."

So far then, so good, but this was not sufficient for a first rate job.

Referring to *Fig.* 1 again it is clear that whilst A to X is dug 3 feet deep, X to W is possibly only the original depth of the field drain say 6 to 18 inches. These two will obviously not throw the same shadow, and a bad photograph will result. Further, the splitting up of a long plot by a trench crossing it at 20 yards intervals necessitated by the traversing will draw attention. It therefore became necessary to subdivide the adjoining country skilfully by means of dummy drains, so that for an appreciable area, suitably " shaded " off small plots abounded. This was done.

Fig. 2. shows the job practically complete from only 2,000 feet. The dummy runs from A to O. A to P is ordinary trench to standard depth and width. A to Q.R.S.T.U.V.W.H.J.K.L.M.N.G.A1.B1. C1. D1, is the concealed trench. Q to T is cleaned drain. S to O is dummy drain.

The result of the dummy " treatment " as regards drains is clearly shown by looking at *Fig.* 2 :—

1. H to J which is 3 feet deep.
2. J to B which is 6 in. deep " treated "
3. B to a which has not been " treated " yet.

Fig. 3. is a horizontal photograph of point A.

Fig. 4. shows standard dummy trench.

Fig. 5. shows a deep trench merging into dummy by an incline.

I will now describe how these results were obtained. It is all a question of obtaining the same shadow by different means. The shade of any particular colour does not play a very important part in aeroplane photographs. Shadow and texture are the things to watch.

Fig. 6. shows the section of a dummy trench. Points to note are:—

1. All sides to be vertical so as to cast maximum shadow.

2. The drain is put in on the Southern side and increases the shadow thrown by some 6 to 9 inches.

3. Brushwood accentuates the shadow: it dies black.

4. In fire bays the width of brushwood is increased.

Fig. 7. shows a section of the concealed communication trench. The parapets are of course not bullet-proof. This I agree is opposed to the " old traditions," coming down to hard facts, in other words the man who has to use the trench, we find that he prefers to be immune from fire owing to invisibility rather than to draw fire which the parapet is designed to withstand. At least this holds for a purely

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battle position on which the fine arts of stationary warfare are not going to be employed.

Fig. 8. shows a section of the cleaned drain. *See Fig.* 2. Q to T. It might occasionally be necessary to make the parapet on the south side higher than that on the North to increase the shadow.

Fig. 9. gives section of dummy drain. *See Fig.* 2. S to O.

Fig. 10. shows the concealed trench where it traverses across a plot. *See Fig.* 2. S to T.

I am not giving any figure as to man-hours for this job, but I would remark that the supervision required is of a very high order.

This particular trench system was further elaborated by putting in a complete dummy system about 150 yards "out of phase" with the real.

So much for the invisible trench.

Ground which appears in the form of plots on a photograph readily lends itself to the concealment of wire. The method is to put a belt of wire entanglement symmetrically cutting off the end of a plot or down one side of it. This then merely looks like a different crop in an aeroplane photograph, and is consequently left alone. However something must be provided to reassure the enemy. Studying aerial photographs of wire, we find that they look like furrowed or spitlocked ground with a very well defined path down either side where the wiring party has walked. The method of obtaining dummy wiring is very quick and effective. It consists merely in drawing a harrow irregularly in front of the position in a wavy line with numerous sharp salients and re-entrants, lastly marching men to and from work on the outside and inside of the harrow marks and always parallel to it, and you have a most perfect representation of wire entanglement. A refinement for trench digging is also suggested by this "plot" method and has been tried with success. It becomes necessary, suppose, to dig a trench (full depth of course, not dummy) along a row of trees. It should be so arranged as to be on the south side of the trees provided this gives the required field of fire. Then the shadow cast by the trees, especially when in leaf will easily blot out all sign of trench. However at midday, at any rate, it will be found impossible to wholly eliminate all show of the spoil in the shape of the parapet.

Even if it is in ploughland the earth last excavated which will now be on top will not be the same colour as the plough, *e.g.* it may be white chalk. If it is in crops the texture will be different. So some earth from the parapet should be scattered from the edge of the parapet forward along the whole front of the trench, the line of intersection of scattered earth and plough or crop being at right angles to the two sides of the field, which are at right angles to the line of trench. Thus a new sub-plot is formed which looks quite natural from the air.

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We now come to a model village defence—St. Sylvestre Cappel on the Cassel-Bailleul Road. These are the examples of the other form of camouflage where "props" are employed, and, I consider legitimately, on small specific objects.

Fig. 11. is an aeroplane photograph of the village; the arrows denote machine gun emplacements. I will confine myself to the machine gun emplacements. Their internal design was standard, being pit prop cubes heavily sandbagged all round and with a bag, "Elephant" steel, and concrete burster, roof. When I say "cubes" I mean that the framework is so braced as to give the frame the resisting properties of a solid cube.

Fig. 12. shows an emplacement in a field arranged to look like a natural mound. For this, knots of grass on wire netting were employed; suitably painted. By this means a very large loophole, 18" high × 5 feet wide at the muzzle, was obtained without the use of a box loophole which constricts fire so much. The gun is fired through the netting, which is quite transparent from inside, but externally, reflects as much light as the surrounding grass field.

Fig. 13. shows an emplacement surrounded by a dummy wall only one brick think. The loophole is canvas painted. Vision is possible through the canvas. In action the gun is fired through the canvas, destroying it.

Fig. 14. shows a close view of a canvas (painted) loophole in the wall of a house (photograph taken from 2 yards).

Fig. 15. shows a dummy sandheap on a roadside. This consists of a frame of expanded metal raised on pickets then covered with a 1" coat of cement and sand and pebble blasted. This was so realistic that I had to put up a railing to keep lorries, etc. off it. In this particular instance the pit prop cube was dug in so as to be 18" only above ground level, *i.e.*, the height of the loophole above ground.

Fig. 16. is an emplacement arranged to similate a ramp from the road to a field. I have seen men resting against the loophole quite oblivious to the fact that they were on top of an emplacement with a "Baby Elephant" shelter dug in under the bank to house the gun team.

Fig. 17. shows the exterior of an emplacement built in a house with shuttered window. The loophole is covered with zinc gauze which is painted. Vision from inside is very good indeed and the gauze is quickly shot away in action.

In conclusion I would reiterate that none of this work is feasible in the—for the time being—battle line. It is only possible on a prepared position, where, when the system comes into action, time has to be gained while reserves are organized and a breakthrough is to be prevented. All this work was designed to fulfil very clear and special conditions only holding in March and April 1918. An

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attempt to employ it universally would be a failure, but the general ideas are capable of adaptation to other conditions.

My acknowledgements are due to the assistance afforded by the O.C. Squadron. R.A.F. All horizontal and aerial photographs were taken by his squadron. Also to 2nd Corpl. G. F .Senior, 227th Fd. Co. R.E. who did all the painting, colour matching, etc, the excellence of which is clearly apparent from the photographs and who was "mentioned" for his skill. Perhaps I may also be allowed to say that this was all original work for which the officers and men of the 227th Fd. Co. R.E. we resolely responsible as regards ideas, design, and execution.

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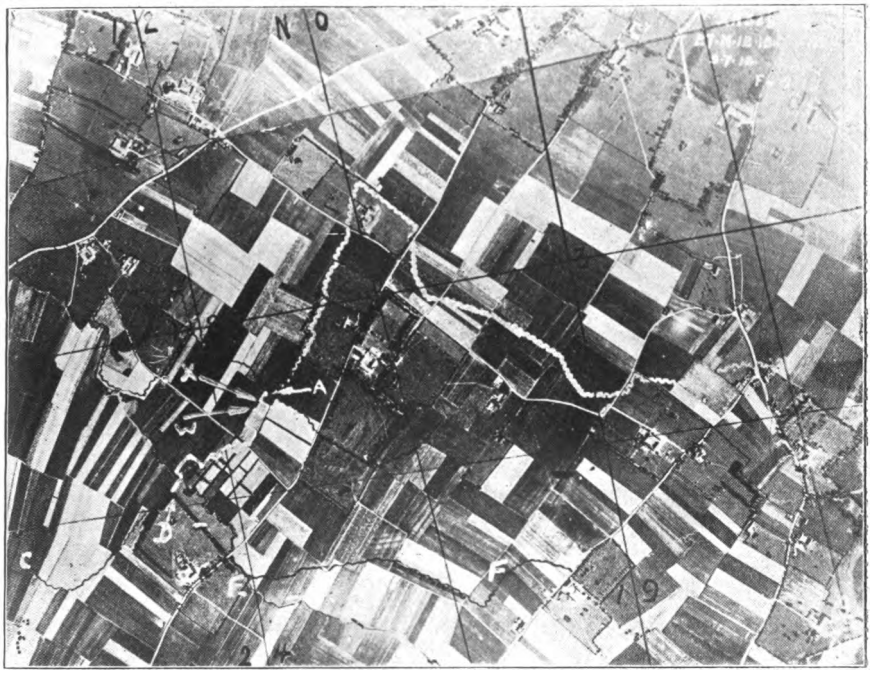

Fig. 1.

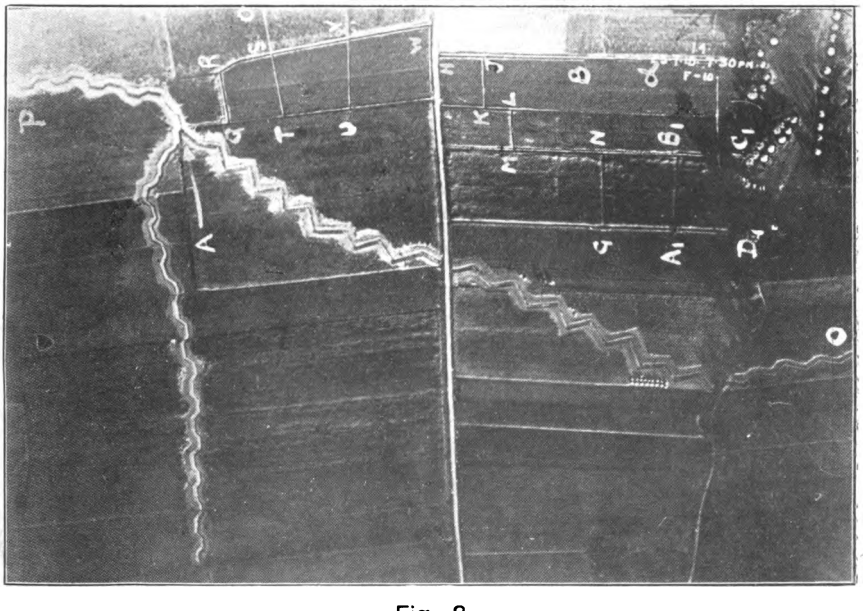

Fig. 2.

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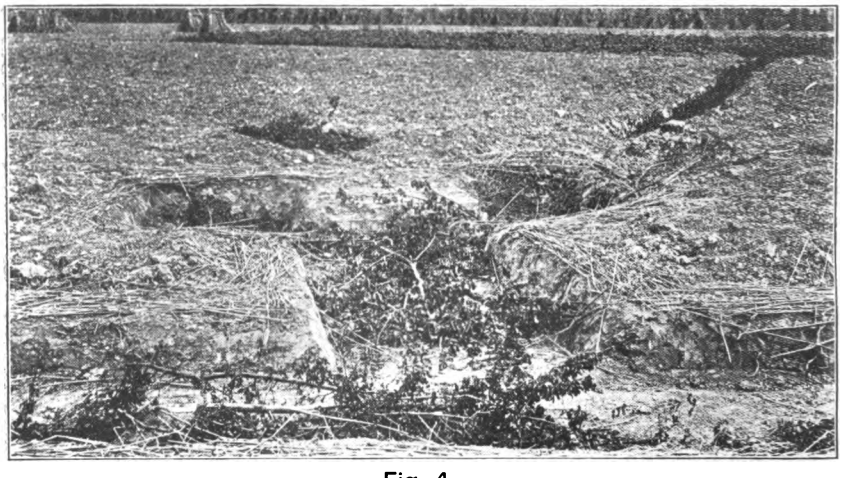
Fig. 3.



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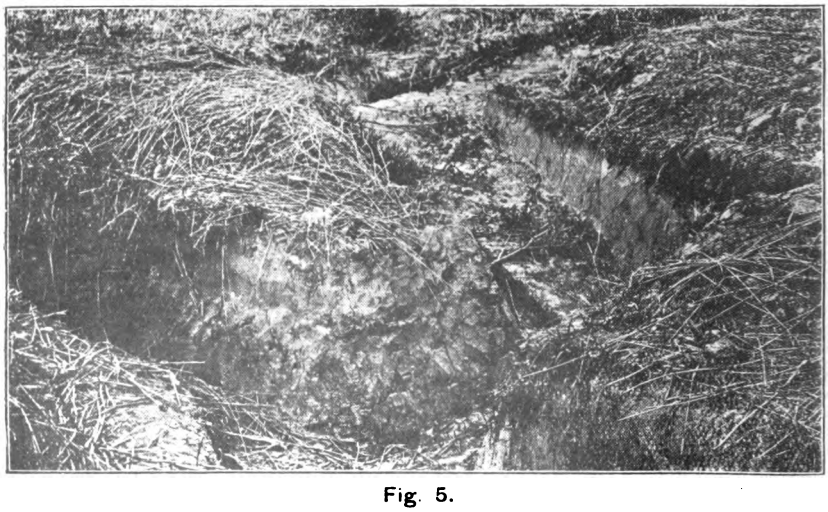

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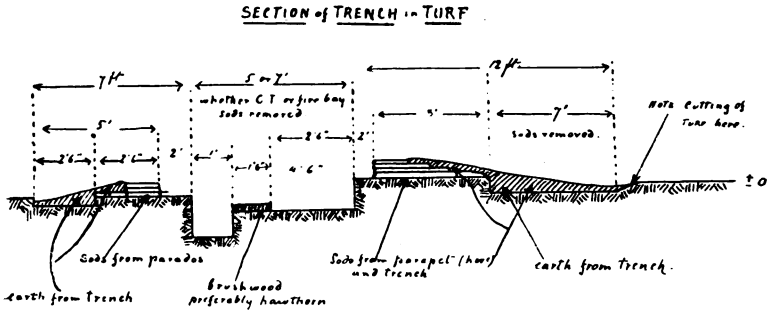

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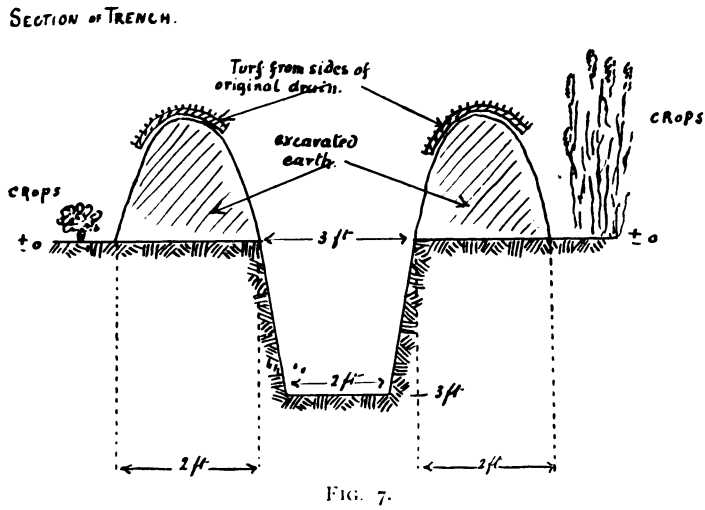

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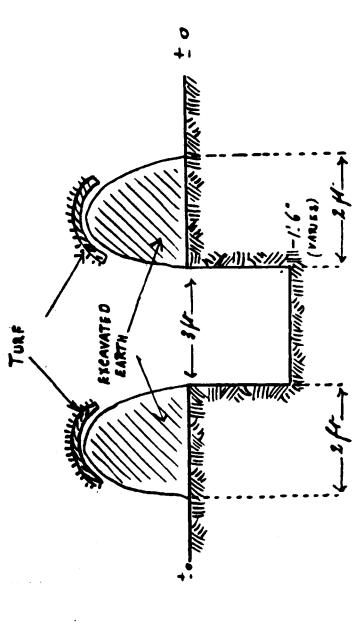

FIG 8.

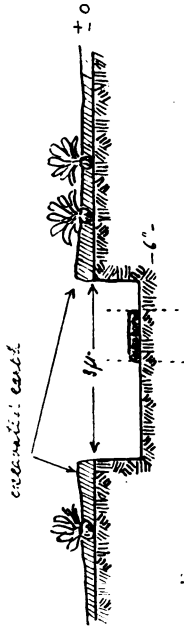

FIG. 9.

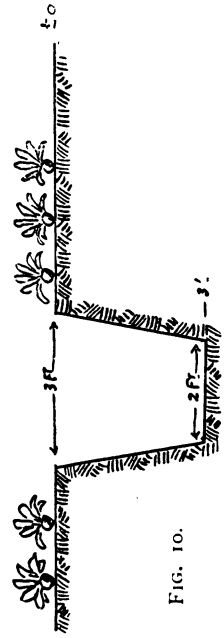

FIG. 10.

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Fig. 11.

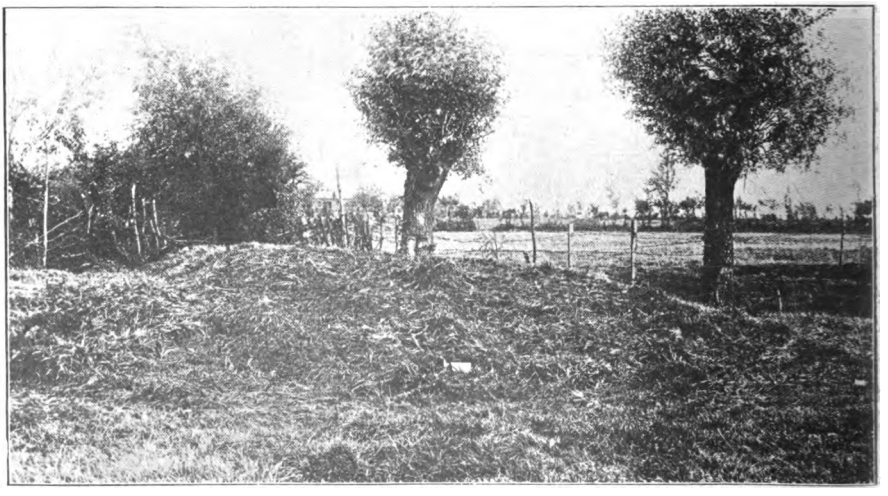

Fig. 12.

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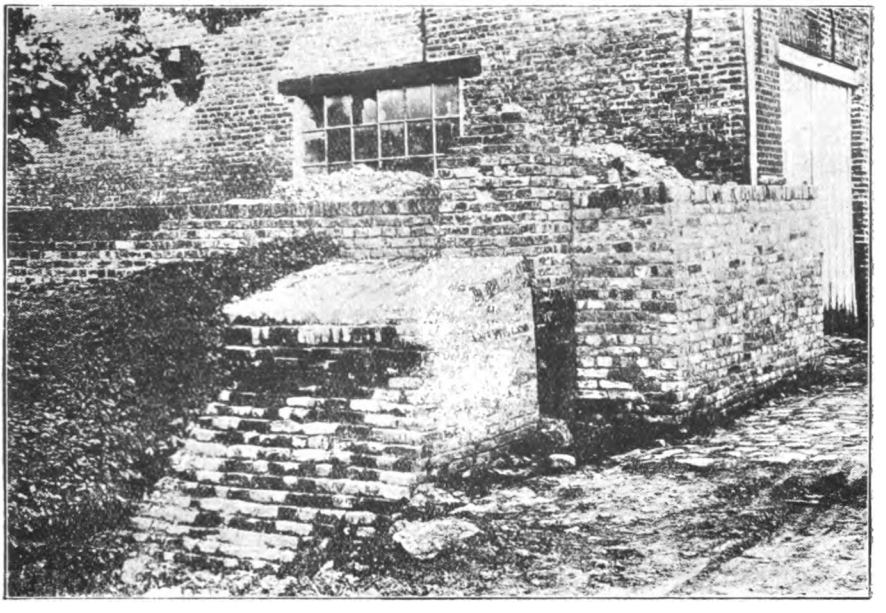

Fig. 13.

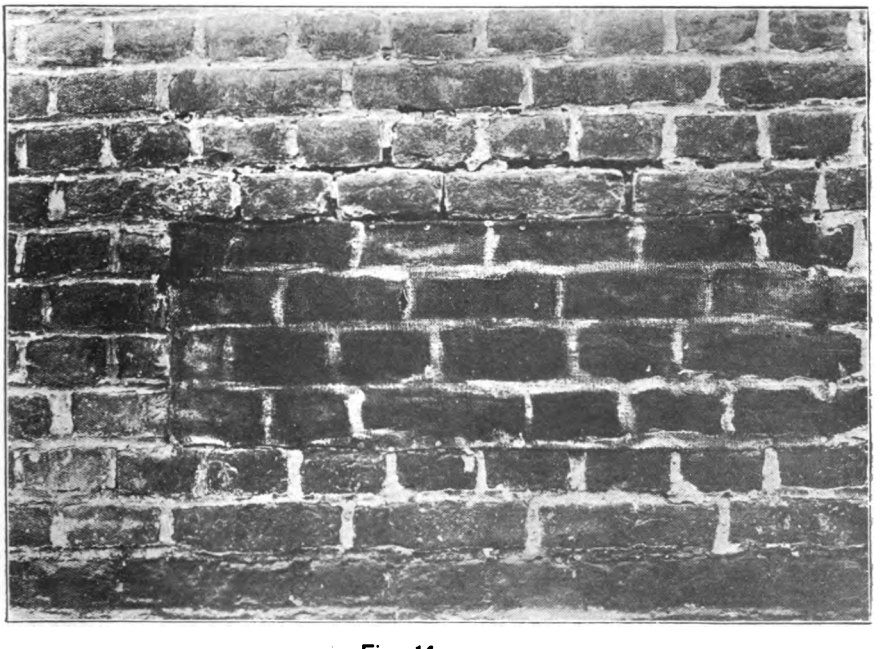

Fig. 14.

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Fig. 15.

Fig. 16.

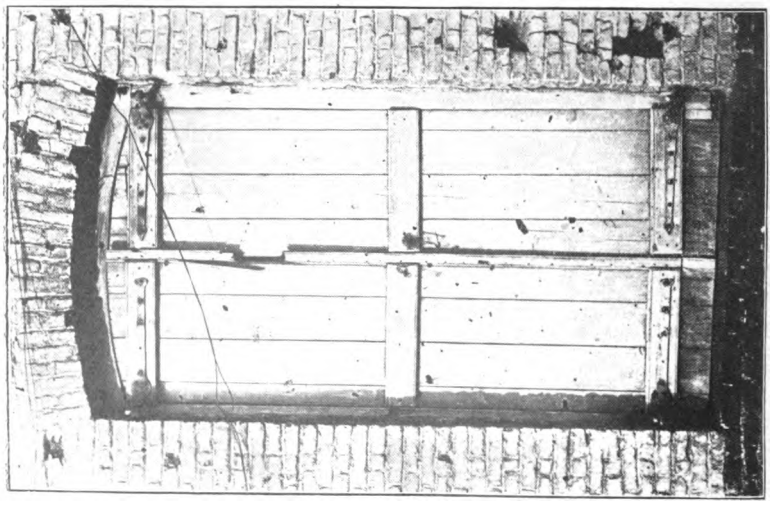

Fig. 17.

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THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914—1919.

PART IV.

WORK IN THE FIELD UNDER VARIOUS BRANCHES OF THE STAFF.

SECTION 3.

FORESTRY.

Causes of Formation of Directorate.—Forestry in France, 1916.—Relations with Canadian Forestry Corps, March 1917.—Convention of 1917.—The Comité Interallié des Bois de Guerre.—The Comité Interallié d'Achat de Bois.—Relations with French Forest Service.—Consolidated Indents.—Director.—Formation of Directorate.—British Organisation.—Canadian Organisation.—Armies Area.—L. of C. Area.—Canadian Forestry Corps Area.—Development of Canadian Forestry Corps Central Area.—Canadian Forestry Corps Statistics.—Results.—Machinery.—Light Railway.—Ropeways.—Transport.—Water Transport.—Shipping.—Railways.—Construction.—Traffic.—Metre Gauge.—Distribution.—Special Work.—Development.

APPENDIX A.—Revised Sawing Instructions.—Logging.—Standard Gauge Sleepers.—Standard Gauge Crossing Sleepers.—Sixty Centimetre Gauge Sleepers.—Metre Gauge Sleepers.—Road Slabs.—4in. Road Planks.—Sawn Defence Timber.—Hardwood Boarding.—Offcuts.—Poles and Pickets.—Telegraph Poles.—Round Timber and Brushwood Supplies.—Hurdles.—Fascines.—Brushwood Bundles.—Continuous Revetting Bundles.—Poles.—Bayonet Sticks and Blob Sticks.

1. *Causes of Formation of Directorate.*—The loss of shipping in 1916 made it impossible to continue the import into France of the large quantities of timber required by the Armies which had hitherto been obtained from Sweden, Russia, and Canada. It was known that France possessed valuable and extensive resources in standing timber which were being exploited on a small scale by the British Army. A convention was accordingly made with the French Government by which, in return for shipping facilities and assistance, *coupes* (felling grants) were granted to the British Army sufficient to maintain two battalions (2200 strength) of Canadian Foresters, and, in the event of Canadian personnel becoming available in excess of 2 battalions, the French Government undertook to supply other *coupes* either on payment in cash or in kind, as might be deemed desirable by the War Timber Committee which was created to carry out the provisions of the Convention. This Committee was required to examine in detail the requirements of the Allied Armies upon a basis of not less than a three months' indent, and preferably on a six months' indent, and, with this information, and with the knowledge of the resources and production of the Forestry operations in France, to arrange with the Admiralty for the shipping required to bring to France what timber was required to meet the needs of the Allied Armies, over and above that produced

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by Forestry. The Convention laid down that except with the consent of the French Authorities, the purchasing power of the British Army should be limited to the acquisition of small quantities of local timber in the Armies zone by Chief Engineers of Armies and Corps and C.R.E.'s of Divisions.

2. *Forestry in France in* 1916.—At the date when the Convention came into force (15th November, 1916) Forestry operations were being carried out on a small scale in Army Areas and on the L. of C. The personnel employed consisted in the Army Areas of working parties drawn from the Infantry under the orders of Chief Engineers of Armies and Corps, and in the Lines of Communication Area of two R.E. Labour Battalions, 2½ Army Troops Companies R.E. and attached details, working under the supervision of the Forests Branch of the Directorate of Works.

The British Forestry Mission had made arrangements for two Canadian Forestry Companies to work in Central France, where they commenced work on the 27th November, 1916. Advantage was taken of the opportunity afforded by the conclusion of the Convention to take steps for the formation of an independent Directorate to deal with the many problems ancillary to extensive development of forestry operations for the Armies in France.

All British skilled personnel was accordingly formed into recognised Royal Engineer units under the control of the Directorate of Forestry, which came into active operation on the 10th March, 1917. This Directorate, with others, was taken over for administrative purposes by the Quartermaster General during the summer of 1918.

3. *Relations with C.F.C.*—As regards the Canadian Forestry Corps, the Directorate was required to indicate to the C.F.C. the location of forestry operations and the requirements of the British Army as to the sizes and types of the products therefrom, while the actual operations were left to the C.F.C. to be conducted by them entirely under the direction of their own staff.

4. *March,* 1917.—Forestry operations were in active progress in the following areas by the end of March, 1917 :—

1. Army Areas.—Forest of Nieppe, State Forest, and minor operations.
2. L. of C.—Eawy, State Forest; Brotonne, State Forest; Haute d'Eu, State Forest; Basse d'Eu, State Forest; Crecy, State Forest; St. Evroult, Private Forest; Rouvray, State Forest.
3. Central Area.—Blanchelande, Private Forest; Parc de Conches, Private Forest; Forêt de Conches, Private Forest; Bois Normand, Private Forest.
4. Jura Area.—La Joux, State Forest; Boujaille, Communal Forest.

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5. *Convention of* 1917.—Early in 1917 it was perceived that the needs of the Armies were larger than could be provided for under the Convention of 1916, and that there was foundation for the French claim that the advantages which they were to secure under the Convention had not in fact accrued to them, and could not accrue to them. The Convention of 1916 was replaced after negotiations by a Convention which came into effect on the 1st October 1917. The British Government had to maintain 56 companies of the Canadian Forestry Corps. Ten of these companies were to work exclusively for the British Army in forests provided by the French, at the expense of the British Government. The product of the labours of the 46 remaining companies, who worked in forests provided by the French Government free, was to be divided between the two Governments under the conditions of exploitation which the experience of previous months had shown to be necessary on economic grounds. The question of tonnage was excluded from this Convention and remitted for solution to the Ministers of the two Allied Governments, who were primarily responsible for shipping matters.

The provisions of this Convention rendered possible the development of the operations of the Forestry Directorate, and from that date to the conclusion of hostilities the association of the British Forestry Service with the French became more intimate and easy.

6. *C.I.B.G.*—The Comité Interallié des Bois de Guerre was formed, and controlled the acquisition of standing timber in France for the Allies. It was most successful in this, and was able to check the inflation of prices due to profiteering.

7. *C.I.A.B.*—The above Board was distinct in origin, function and composition from the Comité Interallié d'Achat de Bois, whose operations extended to the acquisition of timber from Scandinavia, Canada, and Switzerland, for the purposes of the Allies.

8. *Relations with French Forest Service.*—As is well known, the importance of forests as a national asset is vividly recognised in France, where, since the days of Napoleon, admirable efforts have been made to conserve the State Forests on sound scientific lines.

Forest exploitation in times of war has to go faster and more extensively than is allowed in the leisurely times of peace. But rich and extensive as are the forests of the State, it would be impossible in the interests of the future to allow reckless felling uncontrolled by regard for sylvicultural conditions. Clear felling has only been permitted in artificial (pine) forests, and then sometimes only on the condition of resowing. In natural forests, private as well as public, the trees to be felled are marked. Reserves are kept and the interests of the future zealously safeguarded by the Commission Forestière d'Expertise. Within these limits operations have been conducted, and though in early days there was criticism well founded, the relations of those engaged in forestry work with

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the French Forest Officers were marked by great cordiality and reciprocal esteem.

9. *Consolidated Indents.*—The policy of forecasting the requirements of the Army on the basis of six months' supply, has been followed throughout. An indent over a long period is necessarily on generous lines. All possible combinations of circumstances, all possible permutations of policy are reckoned on, so that, whatever may happen, provision will have been made by the provision of the services against every eventuality that war may force upon the armies.

The indents were always scrutinised closely, discussed with the Directors of the Services, and approved by the Q.M.G., after the fullest consideration of the possibilities of production, in estimating which it was essential to bear in mind that the organisation of forestry exploitation is by no means simple. Apart from the many factors which have to be considered in planning the working scheme for a big forest, such as problems of mill and camp sites, railway facilities, water supply, and methods of extraction, it is not an easy thing when once exploitation has actively started to modify specifications without seriously diminishing production. Trees when felled in the forest have to be cross-cut to proper lengths before being hauled to the mill. The lengths are fixed after expert consideration of the commodities which have to be produced. Any change of policy and of specification retards production until all the new adjustments have been made. Production had to be kept up at full rates. It was therefore impossible to undertake fancy work, and the value of standardisation as the essential condition of production on a large scale is admirably illustrated in the case of timber from the forests. Appendix A. shows the scheme of sawing which was in force, as illustrating the policy of standardisation.

PERSONNEL.

10. *Director.*—Brigadier-General Lord Lovat, K.T., K.C.M.G., K.C.V.O., C.B., D.S.O., A.D.C., assumed duty as Director on March 10th, 1917, and remained in charge throughout. The Headquarters Staff consisted of 14 British and 4 Canadian Officers.

11. *Formation of Directorate.*—The Directorate was formed of two main divisions—(1) General Administration, and (2) Technical Equipment and Organisation.

Under the heading General Administration were comprised departments dealing with Production, Statistics, Contracts and Purchases, Personnel, and *Liaison* with the War Office, Controller of Timber Supplies, French Military Mission (Forestry Section), Comité Interallié des Bois de Guerre, and Comité Interallié d'Achat de Bois, and the co-ordination of the work of these departments with the technical departments.

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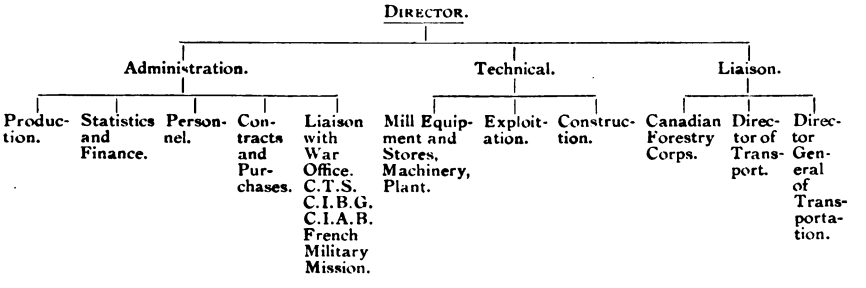
Under the heading "Technical Equipment and Organisation" were departments dealing with the purchase of machinery and equipment, installations of mills and technical engineering, and forestry exploitations. Special officers were appointed as Liaison Officers with the Canadian Forestry Corps and the Directorates of Transportation and Transport.

With this organisation, at every stage effective control was exercised by expert officers over the work in the forests, and to secure closer co-operation and the exchange of ideas, weekly meetings of heads of departments were held with the Director, at which problems were discussed in common, the progress of operations surveyed, and policy shaped according to the requirements of the military situation.

The organisation of the various groups followed on similar lines.



12. *British Organisation.*—(1). British Organisation was divided into three groups :—

(*a*). *Armies Areas Group*, consisting of a Forest Control attached to each Army Headquarters and 5 skilled R.E. Forestry Companies. The Group Headquarters controlled all forestry operations in Army Areas, and supervised through the controls and skilled companies a large force of unskilled labour (P. of W., Chinese, and Indian) which ultimately numbered 9,000 strong. Seven Canadian Companies also worked in this group.

(*b*). *Lines of Communication Group*, consisting of six forest districts situated for the most part in large state forests in the Seine Inférieure, and six R.E. Forestry Companies with the Group Headquarters at Rouen. The Forest of Castets in Les Landes was taken over by the L. of C. on its evacuation by the A.E.F. in 1918. The maximum strength of the unskilled labour employed in this group was 13,000 (mostly Prisoners of War and Chinese coolies).

(*c*). *Paris Staff*, under an Assistant Director, who acted as British Representative on the Comité Interallié des Bois de Guerre, and Comité Interallié d'Achat de Bois, with Subordinate Staffs :—

(i) For estimation and purchasing duties in Central France, and at a later date in the Landes and Gironde, and

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(ii) For despatching work at Bordeaux and Bayonne. This organisation was responsible for the entire purchase, estimation, and valuation of timber bought outside the British zone, and for the despatch of forest produce from the Landes Forests by sea to Northern Ports.

13. *Canadian Organisation.*—(2). Canadian Organisation consisted of a Headquarters controlling three main groups :—

Central Group.—2 Districts, 14 Companies, operating in a large area south-west of the Seine.

Jura Group.—3 Districts, 19 Companies, operating in the Vosges and Jura Mountains and in the department of Haute Marne.

Bordeaux Group.—2 Districts, 18 Companies, operating in the departments of the Landes and Gironde, together with seven companies working in the Armies Areas.

The total personnel numbered 425 officers, and 11,225 other ranks, and supervised up to 6,500 labour (Prisoners of War).

Each of these divisions formed a separate entity with peculiarities and characteristics due both to their previous history and to the natural features of the area in which they worked. Each division had to deal with special problems and each therefore deserves separate note.

14. *Armies Area.*—In the Armies Area the organisation had grown out of, was part of, and always remained in close contact with the Armies. This intimate association was of peculiar advantage to the Directorate, as it enabled its operations to be appreciated and understood by those for whose benefit and assistance they were carried on. The Armies Area is poor in State Forest resources, and it was necessary to supplement the grants made by the French authorities, through the French Military Mission, in their State Forests, Nieppe, Clairmarais, Tournehem and Crecy, by extensive purchases from private owners. A staff of expert timber buyers was maintained to this end, and, while from time to time serious difficulties were encountered, in the main the supplies of standing timber were well secured. It was laid down that recourse was not to be had to requisition unless it could be conclusively shown that a fair and reasonable price had been offered, that it had been unreasonably refused, and that the standing timber was in fact required. Various devices, maximum and minimum scales of prices, etc. were proposed and tried from time to time to meet the difficulty of fixing a fair price, but the industry, patience, ingenuity, and tact of the expert purchasers obtained the trees which were needed to keep the mills going at a cost which, regard being had to the special difficulties of this Area, must be regarded as eminently moderate.

Brushwood Supplies.—In the Armies Area the following quantities of hurdles and fascines were made for the Northern Armies for the

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maintenance of their trenches and forward roads, during the period May 1917 to November 1918 :—

Fascines	85,098 Tons.
Hurdles	24,145 Tons.
Pickets	92,570 Tons.

15. *L. of C. Area.*—In the L. of C. area where operations had been commenced by the Director of Works, conditions were more stable.

The French Forest authorities conceded *coupes* in the rich State Forests, and the supply of forest produce to the depôts was steadily maintained by an efficient and economical administration. Unskilled labour was employed in this area in large numbers with marked success.

16. *C.F.C. Areas.*—The areas exploited by the Canadian Forestry Corps were rich in standing timber and suitable for the vigorous methods, the skill and mechanical genius of the professional lumbermen, who tackled with characteristic ingenuity and with complete success the difficulties of work in the rolling uplands of the Central plain, in the rich pine forests of the Landes, and the fir-clad slopes of the mountains of France's Eastern Frontier.

17. *Development of C.F.C. Central Area.*—The first operation entered upon by the C.F.C. was Bois Normand in the department of the Eure. At the end of 1916 two operations were in progress in the Central Area, South of the Seine. At the end of 1917 fourteen operations were in progress. The total number of operations in this area was 28, of which 9 were State Forests (Perseigne, Andaine, Belleme, Ecouves, Bourse, Senonches, Rouvray, Bord and La Trappe).

Jura and Vosges.—The first operation in the Jura was commenced by the C.F.C. in March 1917 at La Joux, a State Forest.

At the end of 1917, ten operations were in progress. The total number of operations which was entered upon in this area was 17, of which 6 were in State Forests (La Joux, La Fresse, Levier, La Vologne, Noiregoutte, and Gerant) while the remainder were owned by the Communes.

Les Landes.—The C.F.C. operations in this area commenced in July 1917 at La Saussouze. By the end of 1917 six operations were in progress, and in all 16 operations were carried on in this richly-timbered area, none of which were in State Forests.

Forests.	1917 March.	1917 Dec.	Total number of forests exploited.
Armies Area	2	4	4
L. of C.	7	7	7
C.F.C.—Central	5	14	28
Jura and Vosges ...	2	10	17
Les Landes	—	6	16
	16	41	72

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In the Armies Area there were over 20 minor operations not counted as forests.

Personnel.	March, 1917	Dec. 1917	Nov. 1918
Number of Companies at Work:			
R.E.	—	4	11
C.F.C.	3	56	58

18. *C.F.C. Statistics.*—It is estimated by the C.F.C. statisticians that, excluding operations in Army Areas (British and French), they felled 1,898,267 metres cub. of standing timber as under:—

Central Group	714,075
Jura Group	463,600
Bordeaux Group	720,592

which yielded the following quantities of produce:—

	Sawn.	Round.	Fuel.	
Central Group ...	385,580	145,616	169,463	tons
Jura	276,624	2,956	110,577	,,
Bordeaux	379,077	10,687	162,970	,,

Their operations in all comprised the conversion of 2,199,067 metres cube of standing timber into 1,246,947 tons of sawn timber, 225,508 tons of round timber, and 616,396 tons of fuel.

19. *Results.*—The extent to which the Forestry Directorate succeeded in reducing imports of timber and releasing shipping for other purposes is shown in the following table:—

TABLE P. 1.

Period.	INDENT.	DELIVERIES.				
			From French Forests.		Imported by Sea.	
	Tons.	Total. Tons.	Tons.	Percentage.	Tons.	Percentage.
April 1917— Sept. 1917..	752,231	774,822	426,208	55%	348,614	45%
Oct. 1917— March 1918.	753,928	748,126	669,735	89½%	78,391	10½%
April 1918— Sept. 1918..	782,027	815,885	752,038	92%	63,847	8%
October and Nov. 1918..	294,278	231,869	217,093	94%	14,776	6%
	2,582,464	2,570,702	2,065,074	—	505,628	—

These figures include indents of a special nature which could not be met from France.

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The production from French forests rose steadily from 51,330 tons in April 1917 to a maximum of 278,077 tons in July 1918. (Table P.2).

2,570,702 tons were supplied to the British Army, 399,147 tons to the French Army, 19,932 tons to the American Army. Reserves which at the end of September 1917 amounted to 172,465 tons, little more than five weeks' supply, had by the end of November 1918 been built up to 692,457 tons, nearly six months' supply, and were adequate to meet all contingencies and fluctuations of the military situation.

As will be seen from Table P.3 that in twenty months over one million tons of sawn timber were supplied to the Director of Works and Director of Engineering Stores. 5,780,000 slabs were provided for road making. 24,000 tons of telegraph poles were delivered for the Signals Service. The supply of sleepers was 4,171,000 standards, 1,315,000 metre, 3,050,000 60 cm. for light railways, and 356,000 tons of fuel wood were delivered to the Armies.

TABLE P. 2.

PRODUCTION.

Summary.

April 1917—November 1918.

	Sawn	Round.	Fuel.	Total.
1917.				
April	16,191	20,028	15,111	51,330
May	24,259	25,085	19,201	68,545
June	40,735	25,401	28,559	94,695
July	39,654	15,383	19,583	74,620
August	52,093	10,881	24,264	87,238
September	85,574	18,939	45,227	149,740
October	76,609	16,758	44,353	137,720
November	90,095	21,650	62,188	173,933
December	65,684	18,988	50,160	134,832
1918.				
January	75,200	28,949	50,088	154,237
February	102,885	41,629	69,068	213,582
March	86,334	52,850	53,931	193,115
April	81,785	43,890	51,872	177,547
May	119,710	32,507	74,166	226,383
June	111,915	36,725	59,307	207,947
July	148,944	41,187	87,946	278,077
August	129,737	36,226	69,011	234,974
September	120,527	37,173	70,383	228,083
October	132,063	39,312	84,513	255,888
November	74,612	8,427	60,688	143,727
Total ..	1,674,606	571,988	1,039,619	3,286,213

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TABLE P. 3.

STATEMENT SHOWING INDENTS AND SUPPLIES TO THE VARIOUS DIRECTORATES.

April 1917 *to November* 1918.

Material.	Total for Twenty Months. Indent. Tons.	Delivery. Tons.
Through D.W. D.E.S.		
Sawn Timber, incl. Forest Plkg, Offcuts, and Stayblocks, Road and Mining Slabs	1,041,942	1,035,604
Split Poles, Poles	375,574	289,118
Pickets	170,346	180,822
4 in. Planks	33,333	48,143
Offcuts for Stable Floors	—	6,208
Telegraph Poles	21,426	24,544
,, Arms	1,750	1,211
Fascines, etc.	—	92,709
	1,644,371	1,678,359
Through D. G. T.		
S.G. Sleepers	324,580	347,608
60 cm. ,, ...	49,500	76,227
M.G. ,, ...	66,962	62,630
Crossing Timbers	10,648	9,456
Pitch Pine	37,097	34,316
Hardwood	2,641	5,396
Barge Poles	100	20
	491,528	535,653
Through D. Supplies.		
Fuelwood	358,496	273,135
Fuelwood for conversion to Charcoal ..	88,069	83,555
	446,565	356,690

20. *Machinery.*—The type of machinery installed in the mills varied considerably to suit the local conditions and the specifications which had to be produced.

In large State Forests, where extensive 'cuts' had been allotted, modern Canadian mills capable of high production were erected, and, where considerable quantities of small size timber, hutting, etc., were required, special saws to cut this supply were installed.

In the Armies group where, with one or two exceptions, the available timber only provided for a mill remaining in a wood for a short time, a more portable type of mill, the Scotch mill with Campbell attachment, was used.

Whenever possible Dutch ovens were used so that sawdust might be used as fuel. Mills were invariably lighted by electric light to permit of work being continued at night.

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During the withdrawal in March, 1918, 10 mills had to be abandoned in the Armies areas, and while much of the machinery was ultimately recovered, a certain quantity was lost.

21. *Light Railway.*—Decauville track (60 cm. with 9-lb, 15-lb. and 20-lb rail) was largely used in the forests, operated where possible by mechanical means. Complete light railway systems, well equipped and operated by skilled personnel, were constructed at Brotonne, Rouvray, Conches, Senonches and Crecy. 26 locomotives, 2 tractors, 287 trucks were provided, with personnel amounting to 4 officers and 220 men, under Director of Light Railways.

22. *Ropeways.*—A ropeway was installed in the forest of Colembert (Armies Area) in combination with a 60 cm. mechanical system, and was most effective in delivering produce to the French railway station yard.

A second ropeway of nearly five miles in length was being installed when the Armistice was signed. Its capacity has not been fully tested, but there seems to be little doubt that this means of transport is economical in use, can be constructed rapidly by unskilled labour, with a modicum of skilled supervision, and is of considerable practical utility.

23. *Transport.*—Seven Royal Army Service Corps units were allocated for the use of Forestry (No. 929 Company R.A.S.C.; 55th Auxiliary Petrol Company; 57th Auxiliary Petrol Company; 77th Auxiliary Petrol Company; 78th Auxiliary Petrol Company; 117th Auxiliary Steam Company; 118th Auxiliary Petrol Company.). The strength of this force was 46 officers, 1513 men, 225 petrol vehicles, 45 steam vehicles, 6 travelling workshops with store wagons and 542 horses.

In addition, in the Army Areas, and on the L. of C., transport was provided from the local pools, inclusive of 3 Auxiliary Petrol Companies, and 2 Auxiliary Horse Companies in the Rouen Area, which were specially provided for work in the forests.

Further, a composite Petrol Company was temporarily provided from the Rouen pool in April, 1918, to ensure the delivery of pickets from Crecy forest for the construction of defence lines.

Each Canadian Forestry Corps Company was equipped with transport on Establishment Scale, viz.:—1 lorry, 1 car, 1 cycle with side-car, 73 horses, 5 G.S. wagons, 2 tip-carts, 2 water-carts, 2 travelling kitchens and 12 logging wagons.

Horsed vehicles of many types were used. The principal types were 4-wheel logging wagons, Canadian type, French *binards*, G.S. wagons and sloops for log-skidding.

Steam tractors were used, but were found to be of inconsiderable value, owing to the excessive damage caused to roads.

Petrol vehicles formed the bulk of the M.T. transport. A number

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of lorries were converted into logging lorries by removing the bodies and constructing bolsters to carry the logs.

In many operations where Decauville systems could not be installed, either because the operation was too small, or because local conditions did not permit it, all transport from the bush to the mill and from the mill to the dump was provided by the R.A.S.C. companies.

24. *Water Transport.*—It was possible to develope the use of Inland Water Transport to a very important degree only on the Seine, where a steady and most useful service of barges was maintained. The I.W.T. barge service on the northern canals was used as circumstances permitted, and on the Somme a local service was also employed.

25. *Shipping.*—The produce of the Forests of the Landes and Gironde was shipped to northern ports under arrangements controlled by the Principal Naval Transport Officer. The service was most satisfactory, and as much as 38,000 tons of timber were shipped in a month from Bordeaux and Bayonne. This amount could have been increased but for the serious and prolonged shortage of railway material in that area. A fleet of 75 ships was used in this service, of which 2 were lost by enemy action.

26. *Railways.*—Sooner or later at some point or other, all forestry produce, except such as could be issued locally, had to pass on to the standard broad gauge system.

27. *Construction.*—As a rule the large forests which were under exploitation were not well provided with railway facilities. There are many reasons for this. The forests grow in parts of the country which are sparsely inhabited, and present serious difficulties to railway construction. It was therefore necessary to construct from time to time sidings to receive and deal with timber traffic. Thirty-six such sidings were constructed, ranging in size from a few yards to a siding with 2½ miles of track.

28. *Traffic.*—The small wayside stations which serve forests are as a rule ill-provided with traffic facilities. There is no natural traffic. The small exploitations permitted in State Forests do not in ordinary circumstances require a constant or large supply of rolling stock. It was therefore necessary for the railway traffic authorities to organise special measures to get adequate supplies of rolling stock at the forest despatching stations, the most successful of which was the institution of a regular service between the forests of the Central area and the depôts in the north. Special provision had to be made for the conveyance of the longer sizes of telegraph poles, rakes of tank trucks being used for this purpose.

29. *Metre Gauge.*—From earliest days, constant use was made of the secondary metre gauge lines which served the forests of Basse d'Eu, Crecy and Tournehem.

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30. *Distribution.* (1) *Depôts.* (2) *Local Issues.* (3) *Direct Supply.*—The policy of distribution was to send all supplies to the depôts of the services, except as regards local issues from local resources which attained considerable volume in the Armies Areas where direct relations were maintained with the armies. In cases of emergency, timber products were sent direct from forest dumps by rail to the services at the front. Fuelwood was sent to regulating stations in bulk trains for distribution, thence with other supplies to army railheads. To allow of whole homogeneous trains of forest produce being sent direct to the front, large dumps were accumulated, and it thus became possible to maintain a regular supply when and where needed. At one period when the truck supply in the Central area was markedly irregular and uncertain, arrangements were made with the traffic authorities, by which, to save time, despatches of forest produce, especially of standard gauge sleepers, were regulated and reconsigned to destinations arranged with the construction service.

(4) *Regulation.*—At one time or another, every possible combination of distribution by rail was employed to meet the ever varying conditions both on railways and in the forests. Had not the end come when it did, it would have been necessary to simplify the system of distribution, and to extend the principle of the direct service to its fullest limit.

31. *Special Work. Pickets.*—The great advance of the enemy in March-May of 1918 called for extraordinary and most successful efforts on the part of forestry to maintain the supply of pickets needed for defensive purposes. Ninety thousand tons were supplied between February and May 1918. *Sleepers.*—The construction of secondary strategic lines of communication between the south with the bases of Rouen, Havre and Dieppe, and the battle area north of the Somme, involved the production of large numbers of standard gauge sleepers. In twenty months 4,171,000 standard sleepers were delivered. The supply of slabs to enable roads to be built rapidly was 5,780,000 pieces.

Honfleur.

32. *Development.*—The menace to our Lines of Communication *viâ* Amiens which was finally removed in August, 1918, threw upon the railways a heavy burden. The bulk of the timber came from forests situated south of the railway line from Amiens to Abbeville. The bulk of the army was north of that line, which was taxed to its fullest capacity, and could only deal with a limited amount of forestry traffic. It was obviously necessary to diminish the burden on the railways, especially as regards movement through the bottle neck. Steps were taken in April 1918 to utilise the Port of Honfleur for the despatch of forest produce to the North by sea instead

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of by rail. The produce of the forests of Bord and Brotonne on the Seine was taken by sea-going barges to Calais. The forests of the central area despatched their produce by rail, as facilities offered, to Honfleur, whence it was sent to the north.

Other Developments.—It became evident that, to deal with the important traffic with the Central area, a timber yard was needed where the traffic could be dealt with under suitable conditions. A site was found, and it was proposed to erect thereon a drying plant where by artificial means timber from the forests would be rapidly dried and rendered fit for immediate use as seasoned timber. Military developments rendered these measures unnecessary.

APPENDIX A.

REVISED SAWING INSTRUCTIONS.

D/F.1047.P.

D.D. "E."
D.D.F., L. of C.
A.D.F., Armies Group.

(i). Amended sawing instructions are issued herewith: all previous instructions are cancelled, and should be filed for future reference if required.

(ii). It is essential that all Officers engaged in Forestry operations should be thoroughly conversant with the latest sawing instructions issued from Headquarters, and should strive to utilise every log or pole in the most advantageous manner possible for the needs of the Army. Group Commanders should take particular pains to ensure that all officers under them apply the sawing instructions intelligently and economically.

(iii). It is of first importance that Group Commanders should refer to headquarters any points in sawing instructions which are not fully understood.

(iv). It is of primary importance that the amount shown in the monthly allocation should be despatched, in order that the obligations of the Directorate as a whole may be fulfilled. Suggestions from Group Commanders as to alterations in the amounts of any particular categories which will assist production will be most useful information for determining allocations in subsequent months.

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(v). Unless for special reasons temporary employment is required for men and saws, it is generally inadvisable to undertake manufacture of slats for trenchboards, or similar light work, in Forest Groups outside Army Areas. Facilities for resawing exist at the depôts of the Director of Works.

A.P.O. S.79.
1st Sept. 1917.

LOVAT, *Brig. Gen.*
Director of Forestry.

1. *Logging.* 1. 9. 17.—Felled trees should not be cross cut into logs before it is absolutely necessary for the progress of the work.

The normal cross cutting should not be more than a week ahead of conversion in the mill.

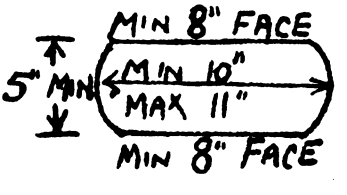
Military requirements will always vary and consequently lengths other than those specified at the moment may be subsequently required.

All cross cutting into logs should be done under close supervision, and with a clear understanding of the specifications attached.

2. *Standard Gauge Sleepers.* 10. 11. 17. *Class* 1.—Species: All softwoods and Oak—Beech up to 20% (maximum). Dimensions: Length, 9 ft.; Width of bottom, 9 in. to 10½ in.; Width of top face, 8 in. minimum; Depth, 5 in. minimum.

Permissible wane not more than 1 in. on either edge, but the minimum upper face of 8 in. must remain.

Also in Class 1.—A flatted sleeper having a minimum face of 8 in. on both faces will be accepted. Width of sleeper from bark to bark not less than 10 in. Edges of these flatted sleepers need not be sawn unless over 11 in.



Class 2.—Species: All softwoods and Oak or Beech. Dimensions: Length, 9 ft.; Width of bottom, 9 in. to 10½ in.; Width of top face, 6 in. minimum; Depth, 5 in.—permissible variation ⅛ in.

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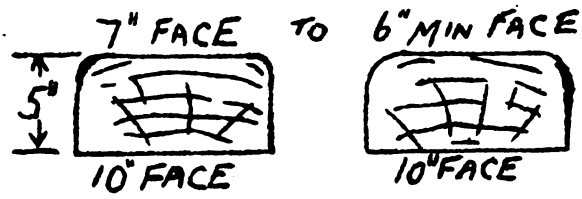
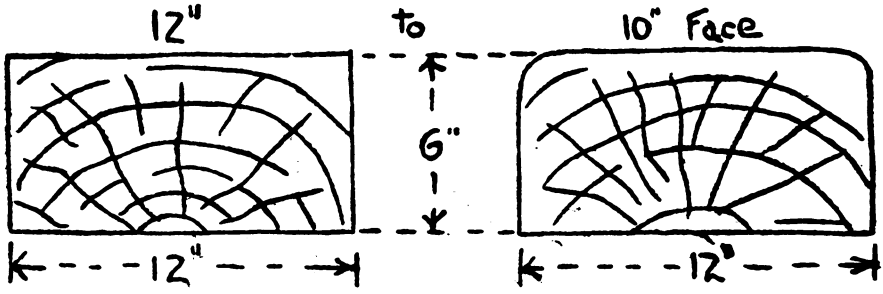
Permissible wane not more than 2 in. on either edge but the minimum upper face of 6 in. must remain.



To be piled in two separate piles according to Class. The different species of Timber (Softwood, Oak and Beech) also to be piled separately and despatched in separate trucks.

3. *Standard Gauge Crossing Sleepers.* (Crossing Sleepers). 1. 9. 17.—Species: All softwoods and Oak. Dimensions: 6 in. × 12 in.—14 ft. long. To be cut ⅛ in. over size.

Permissible variation: wane 1 in. on upper edges, but an effort should be made to supply Crossing Sleepers without any wane whatever. Lower face to be full width and die square.



4. *Sixty Centimetre Gauge Sleepers.* (60 cm. Sleepers) 6. 11. 17.—Species: All softwoods, Oak and Beech. Length: Not less than 4 ft. 6 in. (minimum).

Permissible variation: Bottom Width, 6 in.—7½ in. in 7 in. Sleepers, 7½ in.—8½ in. in 8 in. Sleepers; Top Width: Sleepers must have a minimum upper face of six inches; Wane: The maximum wane on either edge to be in the 4 in. × 7 in. Sleepers—½ in., 4 in × 8 in. Sleepers—1 in., still giving the minimum 6 in. upper face.

5. *Metre Gauge Sleepers.*—Species: Pine or other softwoods, Oak and Beech. Dimensions: Length of Sleepers, 6 ft. 6 in.; Thickness, 4½ in. (minimum); Width of Upper Face, 5 in. (minimum); Width of bottom side of sleepers 7½ in. to 8½ in.

Can be made by splitting poles with the saw in the mill. The poles to be surfaced on two sides and then split.

6. *Road Slabs.*—Species: Hardwoods, including such Oak as is not suitable for conversion to other material. Dimensions: Thickness must be 2½ in. (Sawn ⅛ in. over size); length, 10 ft. 20% may be 9 ft.

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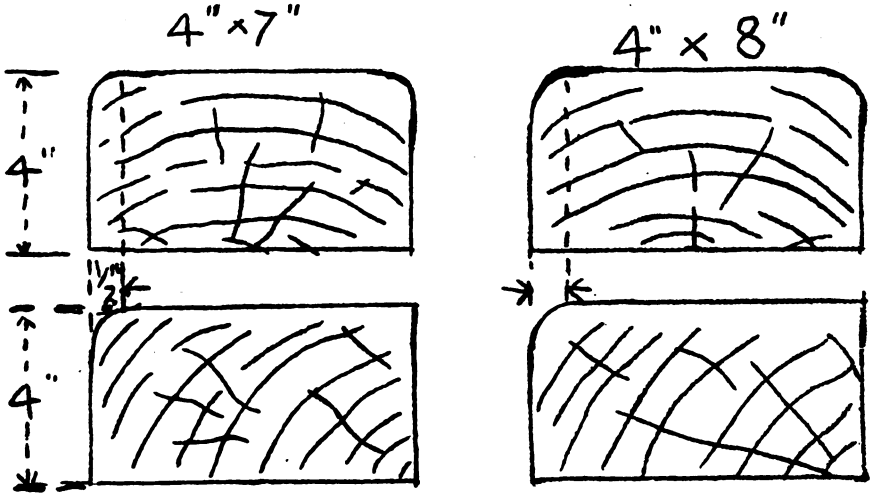

9 in. and up hardwood logs, and Oak as above, to be sawn into Road Slabs and in the largest width obtainable from logs available, and may have waney edges.

Slabs over 20 in. in width, should be sawn in half longitudinally to make two slabs.

If a log will produce one or more Standard Gauge Sleepers with one or more 2½ in. slabs, it should be cut 9 ft. length and produce Standard Gauge Sleepers and Road Slabs all 9 ft. long.

Oak logs large enough shall be converted into Standard Gauge Sleepers. (See page 261.)

7. *4 in. Road Planks.* 1. 9. 17.—Species: Hardwoods, including such oak as is not suitable for conversion to other material. Dimensions: thickness, 4 in.; length, 9 ft.

9 in. and up hardwood logs (and oak as above) to be sawn into road planks and in the largest width obtainable from logs available, *but planking must be edged square.*

Planks over 20 in. in width should be sawn in half longitudinally to make two planks.

Oak logs large enough should be converted into Standard Gauge Sleepers.

8. *Sawn Defence Timber.* 4. 10. 17.—Species: Softwoods. Dimensions: Length 3 ft. and up, and longest average length possible.

All sawn defence timber must be edged square and sawn into the following categories:—

Group.	*Thickness.*	*Width.*	
B.	3 in.	3 in. & up.	Widest average possible.
C.	2 in.	2 in. & up.	
D.	1½ in.	3 in. & up.	
E.	1 in.	3 in. & up.	
J.	All boards under 1 in. in thickness and width.		

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Each group to be piled separately and despatched in separate trucks.

Boards 1½ in., 1 in. and under 1 in. in thickness not to be specially produced, only as falling from the saw.

9. *Hardwood Boarding.*—Species: Hardwoods. Dimensions: Length, 3 ft. and up; Width, 5 in. and wider; Thickness, 1 in. and 1½ in. only. MUST BE EDGED SQUARE.

This should only be produced as necessary from the side cuts made in the sawing of Sleepers, 2½ in. Mining Timber and Road Slabs.

Only exceptional cases or special instructions will warrant logs being wholly converted into this product.

10. *Offcuts.* 11. 5. 18.—At the present time Corps and Army Workshops are not working, and the Base Workshops under the Director of Works are fully employed in sawing mining frames, etc., and no stabling is in the course of construction. Consequently, there is little or no demand for offcuts.

Every effort should be made to slab light, and keep offcuts to a minimum, both as regards quantities and dimensions. It will be seen from Revised Sawing Instructions dated 4/10/17 that Sawn Defence Timber is accepted in lengths of 3 ft. and up.

If this is done the majority of offcuts will be Class 4, suitable only for fuel.

The classification of offcuts will remain as before. Classes 1. and 2. will not be produced unless specially asked for.

Classification of Offcuts.

Class (1). 2½ in. and up thick at the thin end, 9 ft. and up long, to be despatched *with road slabs or split poles.*

,, (2). 1½ in. to 2¼ in. thick at the thin end, 6 ft. and up long, to be despatched *for stabling.*

,, (3). 1 in. to 1¼ in. thick at the thin end, 3 ft. and up long, suitable for resawing, but this class to be resawn at the mill as far as possible, and any surplus should be piled ready for despatch when required.

,, (4). Slabs and offcuts any length, suitable only for fuel to be piled together for that purpose.

11. *Poles and Pickets.* 20. 3. 18.:—

Letter.	Description.	Length.	Diameter at tip.	Primary use.	Remarks.
	Poles Round.				
O.	Stout	... 13 ft.	Over 6 in. up to 9 in.	Uprights of heavy bldgs.	Soft or Hardwood.
P.	Medium	... 13 ft. 6 in.	Over 3 in. up to 6 in.	Uprights and rafters of bldgs. etc.	Hardwood.
Q.	Medium	... 10 ft.	Over 4 in. up to 6 in.	Roads.	Soft or Hardwood. Must be *straight.*
R.	Medium	... 10 ft.	Do.	Uprights of Bldgs, and Dugouts.	Soft or Hardwood.
S.	Medium	... 6 ft. 6 in.	Over 4½ in. up to 6½ in.	Uprights of Dugouts.	Do.
U.	Thin	... 12 ft.	2½ in./4 in.	Screens.	Hardwood.
W.	Thin	...6 ft. and to 8 ft.	2½ in./4 in.	Revetments.	Hardwood.

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Letter.	Description.	Length.	Diameter at tip.	Primary use.	Remarks.
	Poles Half Round.				
X.	Stout ...	10 ft.	From Poles over 5½ in. and up to 7 in.	Roads.	Soft or Hardwood. Must be *straight*. To be split with the saw in mill.
	Pickets.	Under 6 ft. various.		Not to be made unless specially ordered.	

Each category to be piled separately and to be despatched in separate trucks.

12. *Telegraph Poles.* "A" size—25. 5. 18.—Pine or Larch. Sound, straight and free from large branch knots.

Specification.

Length.	Maximum and Minimum diameter at tip under bark.	Maximum and Minimum diameter 5 ft. from butt under bark.
Feet.	*Inches.*	*Inches.*
24	4 in. to 6 in.	6½ to 8½.
26	Do.	6½ to 9
30	Do.	7 to 9½
34	Do.	7½ to 10
40	Do.	8 to 10
50	Do.	9 to 11
60	Do.	10 to 12

"B" size.—Sound, fairly straight and free from large branch knots.

Specification.

Length.	Maximum and Minimum diameter at tip under bark.	Maximum and Minimum diameter at 3 ft. from butt under bark.
Feet.	*Inches.*	*Inches.*
15	1½ in. to 2½ in.	2 in. to 3½ in.
17	2 to 3	3 to 4½
22	1½ to 2½	2½ to 4
24	2 to 3	3½ to 5

13. *Round Timber and Brushwood Supplies* (*Brush*). 1. 6. 18.—In addition to the supplies described in the Revised Sawing Instructions, the following should be produced when trees or brushwood are felled :—

Pickets. The principal source of supply is from *taillis*, but small quantities can also be obtained from straight boughs of trees.

Manufacture.—Sticks should be straight, stiff, and pointed one end, the other end being sawn square, so that they may be easily driven into the ground.

The sizes generally used and of which stocks should be made are :—

Class.	French Size.	English Size.	Av. dia.
Z.S.	1 metre	3 ft. 3 in.	2 in.—3 in.
Z.H.	1½ ,,	4 ft. 11 in.	2½ in.—3½ in.
Z.L.	1¾ ,,	5 ft. 9 in.	3 in.—4 in.
Z.R.	2 ,,	6 ft. 6 in.	3 in.—4 in.

Use.—Z.S.—for anchor pickets of apron wiring.
Z.H.—for knee wiring—placed in front of apron wiring.
Z.L.—for main pickets of apron wires.
Z.R.—for revetting.

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The pickets chiefly used are 1 metre and 1¾ metre, and are used in the proportion of two 1 metre to one 1¾ metre.

The 1½ and 2 metre pickets are used in about equal proportions.

Class Z.X.—In *taillis* it is generally found that the wood suitable for Z.S. and Z.H. pickets is in excess of the proportion required. A stock of pieces suitable for Z.S. and Z.H. cut to length but not pointed may be made, but the stock should not exceed the number of Z.S. and Z.H. Pickets made, and must be stacked separately.

14. *Hurdles.—Source of supply* from selected material in *taillis*.

Use.—Hurdles are used for revetting.

Large sizes are usually preferred for breastworks.

Manufacture.—All hurdles should be made with six pickets, the diameter of the pickets being 1¼ in. to 1½ in. Larger pickets should not be used, otherwise the hurdle becomes very heavy. Lighter pickets, however, are too weak.

The pickets should extend at least one foot below the bottom of the hurdle, and five or six inches above the top.

Pickets should first be driven into the ground at least one foot, being equally spaced, the brushwood being allowed to extend 2 inches outside the end pickets.

The pickets having been driven one foot into the ground, the bottom of the brushwood commences on the ground level.

Hurdles should be made of light brushwood entwined in and out of the pickets, brushwood to be tightly packed, being pressed down by foot at the bottom, and by hand at the top. The ends of all brushwood should be trimmed.

The hurdle should be wired top and bottom, the wires being wound round the picket two or three times, double wire being used. The wires should be twisted up tight by placing a piece of wood between them, and twisting them together.

Wires should also be run between the centre of the hurdle, and the top and bottom of the brushwood; this helps to hold the hurdle together.

The whole secret of hurdle-making is in keeping the wires which hold the pickets together tight, as otherwise, the two end pickets break loose from the brushwood, and the hurdle falls to pieces.

Hurdles are handled many times before reaching their destination, and a badly wired hurdle becomes useless long before it comes to the end of its journey.

Hurdle-makers should either work singly or in pairs. If in pairs, one man prepares the brushwood, the other man making the hurdle.

The sizes generally used and of which stocks should be made are:—

Class.	English Size.	French Size.	Proportion.
Z.H.S.	1 ft. 9 in. × 6 ft. 0 in.	55 cm. × 2m.	15%
Z.H.M.	3 ft. 0 in. × 6 ft. 0 in.	90 cm. × 2m.	75%
Z.H.L.	4 ft. 0 in. × 6 ft. 0 in.	1m. 20 cm. × 2m.	10%

C.Es occasionally require special sizes, but large stocks of these will not be made unless instructions to do so are given.

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15. *Fascines.—Source of Supply.*—From selected *taillis*. If pickets have first been manufactured from the *taillis*, it is best, if the wood is suitable, to make all hurdles possible from the brushwood, and then, where trees are being felled, to wait until this part of the exploitation is finished before working the remainder of the *taillis* into fascines. Fascines made from brushwood only, without any light poles, are of very little use, whereas fascines made from the tops of trees with the remaining brushwood are suitable for road-making.

If trees are not being felled, the brushwood should be bundled up for revetting material or for dunnage.

Use—Principally for roads.

Manufacture.—Brushwood with a good proportion of light poles are placed in trestles so as to compress into a bundle 10 ft. 0 in. long by about 9 in. diameter. The bundle is then choked and wired (double) in seven places, at equal distances, the two end wires being 6 to 8 inches from the ends of the fascine.

These wires must be choked tightly so that no pressure can loosen them, and any ends pushed into the middle of the fascine.

The size of fascines should be :—

Class.	*Length.*	*Av. dia.*
Z.F.	10 ft. 0 in.	9 in. to 10 in.

16. *Brushwood Bundles.—Source of Supply.*—from material in *taillis*, and heads of trees, which is unsatisfactory for the manufacture of fascines but which is sufficiently straight for bundles.

Use—Roads, dunnage, foundations on bad ground.

Manufacture—Similar to fascines, but less care is taken in the selection of material, and bundles are only wired single in four places.

Class.	*Length.*	*Av. dia.*
Z.B.	8 ft. 0 in. to 10 ft. 0 in.	9 in. to 10 in.

The stock of this supply which should be held depends largely on the locality in which the wood is situated.

The supply will only be produced when it has been ascertained that there is likely to be a demand for same.

Frequently the brushwood is issued in G.S. wagon loads, same being tightly packed into wagons.

17. *Continuous Revetting Bundles.—Source of Supply*—From *taillis*.

Use—For revetting trenches, etc.

Manufacture.—Long selected sticks suitable for weaving into basket-work, too small for fascines, are made into bundles.

Five 4 ft. 0 in. pickets being put in each bundle, the bundles being wired tightly in four places for transport. Three bundles should be sufficient to make 20 ft. of continuous revetting 2 ft. 0 in. high.

Size of Bundles.

Class.	*Length.*	*Av. dia.*
Z.R.B.	10 ft. 0 in.	9 in.

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18. *Poles.*—Specifications of poles are given on page 264, (20.3.18) Revised Sawing Instructions. " U " Poles should be cut from 12 ft. 0 in. to 15 ft. 0 in. long, as frequently 12 ft. poles are not sufficiently high for camouflage work.

19. *Bayonet Sticks and Blob Sticks.—Source of Supply*—From *taillis.* Straight clean sticks 5 ft. 2 in. in length about 1 in. dia. at tip, and 1½ in. at butt.

H.Q., Armies Group, Directorate of Forestry.
1st June, 1918.

(Previous articles under the heading of " The Work of the Royal Engineers during the European War, 1914—19 " appeared in the *R.E. Journals* of September, 1919 (Introduction p. 105; Anti-Aircraft Searchlights, France, p. 106; Postal Section—Army Postal Services, p. 114), October (Bridging, Chapter I., p. 162), November (Bridging, Chapter II., p. 200), December (Bridging, Chapter III., p. 261), January 1920 (Bridging, Chapter III., (*concluded*), p. 13), February (Bridging, Chapter IV., p. 61; Organization of Engineer Intelligence and Information, p. 79), March (Bridging, Chapter V., p. 149), April (Bridging, Appendix—Formation of R.E. Bridging School). Copies of these Journals may be obtained through the usual channels.)

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THE EGYPTIAN EXPEDITIONARY FORCE.

R.E. SERVICES IN THE OPERATIONS FROM 1ST SEPTEMBER 1918 TO 15 NOV. 1918. REPORT OF THE C.R.E., DESERT MOUNTED CORPS. DATED 12TH DEC. 1918.

THE R.E. services previous to the actual commencement of active operations on the night 18—19 Sept., 1918, included certain preliminary measures undertaken in the Jordan Valley.

Special efforts were made to complete bridges in hand on the Jericho—Wadi Auja road and to consolidate the metalling already laid. The road north of the Auja across Maskerah to Khirbat Fusail was put in order, the work being done at night, and improvements were effected on those portions south of Wadi Auja where work had hitherto not been possible. As a result the whole of the main road Jericho—Wadi Auja—Khirbat Fusail was rendered fit for traffic when troops moved forward on the 21st Sept.

At the same time a Battle Headquarters was built at Abu Tellul, and splinter-proofs for Signal Office and Artillery Headquarters were provided, while a road practicable for motors was constructed from the Auja Crossing and continued as a pack track on to Musallabeh.

Five large masonry hospital huts were erected for the Australian Casualty Clearing Station, and, with the object of deceiving the enemy as to the direction of the offensive, a number of dummy horses were made and set up in the lines of the cavalry transferred by night to the western flank.

A scale of explosives was made out in order that each Division should be capable of undertaking all the railway and bridge demolition it was anticipated might be found necessary, with the exception of the railway and road bridge at Jisr Mejamie, for the destruction of which a special party was organised.

The explosives for this party were carried in tins and carriers designed in such a manner that the charges could be placed in position and detonated without unpacking, and iron dogs, rope ladders, and other equipment were prepared to enable the demolition to be carried out in the least possible time, in the event of enemy pressure.

The Corps demolition party, divided into two sections under Captain W. Falcon R.E. and Lieut. L. L. Blake R.E. respectively,

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was organised by, and attached to the 4th Cavalry Division, and was given special and practical training in speedy demolition.

Experiments were made in the destruction of permanent way to avoid, as had previously happened, the possibility of trains being able to pass over lengths of line which had been cut. The Turkish rail offers too little resistance to a slab of guncotton if placed in the web at the centre of the rail, and regiments were instructed in the placing of charges at the fishplates, which was found to be more effective.

Parties from Brigades were also instructed in the erection and use of Chursa deep well gear, and the handling of troughs and pumps, the suggestion having been adopted that regiments should carry their own, instead of having to rely on Field Troops, which might have difficulty in keeping pace with a very rapid advance.

In anticipation of possible water difficulties, Field Squadrons were issued with and instructed in the running of Isler-Lyster pumps and engines, and a number of "spares" were collected for the rapid repair of enemy installations should such be met with.

From the available information concerning the country to be crossed on the western flank, difficulty was anticipated at the Nahr El Falik and at the Iskanderuneh, and Field Squadrons were ordered to carry material for negotiating swamps, while 'D' Field Troop A.E., in lieu of their normal pontoon equipment was fitted out with a complete trestle bridge especially designed for rapid erection.

Other preliminary arrangements included the preparation of bivouac areas and watering arrangements in the orange groves around Sarona, Summeil, and Seimeh villages; the reconnaissance of existing bridges crossing the Auja river; and the construction of two additional pontoon bridges for the special use of the Desert Mounted Corps at Jerisheh.

Watering arrangements for horses and men while awaiting the developement of the Infantry attack were also got ready north of the Auja, and, for the actual advance, Divisional flags were made up and issued to demarcate the roads to be followed through our own and the enemy's systems of wired defences.

In order that Field Squadrons should be able to travel as light as possible, a Mobile Park with small R.E. *personnel* on lorries was organised under Captain C. L. Gray, R.E. to follow up the Cavalry as soon as circumstances would permit. Actually the Field Park arrived at El Lejjun, the Headquarters of the Desert Mounted Corps at the end of the first phase of the operations, the same afternoon as Corps Headquarters itself.

For months past squadrons had been very seriously under strength and sufficient reinforcements most difficult to obtain to keep pace with the steady number of evacuations caused by the climate of the Jordan Valley.

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Finally however, on the 19th Sept., every Squadron and Troop was enabled to take the field practically with its full complement of officers, N.C.O's, sappers and horses.

As events turned out no obstacles were met with, and no special engineer work was called for during the first phase of the operations.

Small repairs were effected at El Afuleh Railway Station and five days after the offensive had commenced two engines had been patched up by the 2nd Field Squadron A.E., and 'D' Troop engine drivers were able to run trains between El Afuleh and Belsan, materially assisting the evacuation of Turkish Prisoners of War, for whom the early arrival of the Mobile Field Park had made it possible to erect barbed wire enclosures at El Lejjun. Meanwhile the advance of Chaytor's Force from the Jordan Valley had commenced, and the 1st Field Squadron A.E. was called upon to repair a serious gap where the road crosses an almost precipitous cliff six miles from Nimrin. A hole to a depth of fifteen feet and seventy-five feet in extent had been blown in by the retreating enemy. A temporary retaining wall was very rapidly erected, the hole filled in and the road made passable, the only troops in any way delayed being the actual working party.

From Essalt, where water points had been established, the Force moved to Amman, and a detachment of 'B' Troop was despatched with orders to blow up the railway north of Leban Station, from which direction an enemy force of 6,000 was advancing with 3 trains of ammunition and supplies. Breaks of 150 feet and 1,450 feet were effected.

At Amman the area was reconnoitred for mines, and about one ton of explosives, mostly set charges including the electrically connected mine from the water tower, were collected. A very large number of stick grenades and bombs of all kinds were likewise disposed of either by detonating or burying. Further engineer services undertaken by the 1st Field Squadron A.E. included the repair of the steam pumping plant at Amman Railway Station, the repair of a motor truck captured at Samra, and of a lorry and motor workshop. Work worthy of special mention was done by Lieut. H. A. Lockington, N.Z.E., who succeeded in making serviceable a badly damaged German engine found in the running shed at Amman.

The Squadron laboured under considerable difficulties in attempting to make use of the captured trains, on account of the shortage of fuel and water, but make-shift arrangements were made and useful expeditions to Mafrak and elsewhere enabled much war material to be salved.

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On the western flank previous to the further advance towards Damascus, aeroplane reconnaissance reported the demolition of the central arch of the Benat Yakub Bridge over the Jordan.

'D' Field Troop A.E., who, on account of heavy sand, had been obliged to dump their trestle bridge material, succeeded in collecting suitable timber at Afuleh and were promptly sent forward on lorries. Work however was not permitted till the eastern slopes of the Jordan had been cleared of the enemy, when a high trestle bridge was constructed to span the demolished arch and completed within 5 hours. The lorries were subjected to enemy bombing on arrival at the site.

The further advance to Damascus entailed repairs to broken culverts and roads generally by the 2nd Field Squadron A.E Similar services being rendered by the 4th Field Squadron R.E., accompanying the 4th Cavalry Division along the Eastern route.

On entering Damascus the 2nd Field Squadron A.E. was occupied for a considerable time in repairing and strengthening culverts and bridges, and in assisting during the first few days to get the permanent way and rolling stock into a fit state to resume traffic, work which was also energetically taken up by the 5th Field Squadron R.E. in the Rayak direction.

The further advance from Damascus to Hama calls for no particular mention, but at the latter place aerial reconnaissance reported extensive damage to the road bridge over the Orontes at Er Rastan village. Inferior material only was available at Homs, but the 5th Field Squadron R.E. succeeded in bridging the gap and enabling transport and lorries to cross within 24 hours.

No special engineer difficulties were met with during the final stage of the operations as far as the outskirts of Aleppo, where blown-up bridges necessitated the construction of deviations to admit wheeled traffic into the town. Wherever possible railway reconnaissances had meanwhile been made by officers of the 4th and 5th Field Squadrons R.E. Station buildings were found to have been systematically destroyed, water tanks rendered useless, and in most places points and crossings, and bridges had been blown up. Arrangements for repair were undertaken by railway officials sent up from G.H.Q. as far as Hama. From this point to Aleppo a trolley reconnaissance made by the 5th Field Squadron R.E. had shewn that the repairs necessary were not beyond the powers of the Corps Engineer Services. Former *personnel* of the Railway Staff were collected at Aleppo, and, under the direction of Major J. B. Alexander, M.C., R.E., work was immediately commenced.

At Aleppo itself two very complete demolitions of bridges had been most skilfully made between the Baghdad and Damsacus Stations. Before exploding large oil tanks had been run on to the

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bridges in such a manner that their collapse completely blocked the exits from the town in the Alexandretta direction.

The débris was rapidly removed, the bridges rebuilt, and, on the 15th Nov., two engines, the repair of which had in the meantime been effected, were able to proceed with a construction train to the temporary station prepared at Hama level crossing. A regular train service was then established and run by the Corps between Hama and Aleppo until taken over by representatives of the D.R.S.

The rapid advance and length of communications made it difficult to arrive at any finality regarding the line of supplies to be adopted and the consequent necessity of repair and upkeep of particular roads. Arrangements were at once made regarding the Homs—Tripoli road, but it was decided that this should be in charge of the 21st Corps. An early rainstorm proved that the metalling of this road was quite insufficient to support heavy lorry traffic, and it was agreed that the Desert Mounted Corps should assist with the repair of dangerous bridges and other work from Homs.

Between Homs and Hama Level Crossing two large railway bridges had been completely destroyed beyond the possibility of immediate repair, and it became essential to keep open the road for heavy traffic between these places. Metalling was exceedingly scarce along the route and was collected with difficulty. Little more than patching was possible and in the absence of steam-rollers consolidating the road metal laid was a serious problem. Horse rollers drawn by lorries were utilised with moderate success.

North of Hama, between the town and the new Station, metal was more plentiful, and as this portion was likely to be required for some months, more extensive work was undertaken.

Between Hama and Aleppo a good fair-weather track existed for most of the way, but in the neighbourhood of Maarit En Naaman, Khan Sebil, and Seraikin the road passed over naked rock, and in other places very rough stretches were met with. Local labour, to the number of 2,000 was immediately organised from eight villages, and a fair light motor track was completed after a month's work. At Khan Tuman, 10 miles south of Aleppo, a raised causeway a kilometre long was found necessary to cross a low and swampy belt of country.

Four masonry arch bridges, all within 15 miles of Aleppo, on the Aleppo—Alexandretta road had been blown up by the enemy and were being rebuilt, and steps were be ng taken to clear side drains and improve the surface over the Bailan pass. Three steam-rollers and one motor-roller were found in the Aleppo area, all in a damaged condition. Two had been already repaired and were at work, and spare parts were found in Aleppo and were to be fitted to the remaining two rollers as soon as Turkish evacuation permitted work to commence.

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Field Squadrons were too short-handed to assist in the direction of work on lines of communication, which had therefore been confined to the staff of the C.R.E. The provision of tools was the first difficulty, and proper supervision of unsatisfactory contract labour, owing to the great distance covered and the necessity of undertaking all work at the same time, in anticipation of early winter rains, was almost impossible.

The advent of an Army Troops Company, R.E. and the assistance of 2/155th Sikh Pioneers would it was hoped materially improve matters and though continuous and heavy convoys of motor lorries rendered road-making an impossibility, it was hoped that all essential lines of traffic might be kept open until the completion of the railway relieved the pressure.

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MACEDONIA.

By BRIG.-GEN. G. WALKER, D.S.O.

Ancient Roads.—The Seres road existed in ancient times and followed its present route from Salonika *via* Likovan (Xylopolis) and Lahana to Seres and thence *via* Drama (Drabescus) to Kavalla (Neapolis).

Another route across the Struma (Strymon) ran *via* Langavuk in the Langaza valley *via* Suho (Ossa)—Ahinos to join the Seres-Drama route near Kikna (Sasxa).

The main route from Salonika to Constantinople ran south of Lakes Langaza (Vasilas) and Besik (Bolbe) *via* Langavuk, Bezarkia (Appollonia), Stavros, Vrasta (Arethusa), Neochori (Amphipolis) Kavalla (Neapolis) and so east along the coast.

There seems to have been only one route northwards, viz: a road from Salonika *via* Naresh (Gallicum), Avret Hissar to Karasouli (Idomene) on the Vardar (Axius).

Another, west to east, communication existed, viz: from Karasouli (Idomene) to Doiran (Doberus) and thence down the Bütkova valley to Demi-Hissar, Seres and Drama.

Amphipolis.—On the advance of the British Army from the "Birdcage" line of defences round Salonika (Naresh on the Galliko to the Gulf of Orphano) in 1916, the 27th Division, which had previously occupied the neighbourhood of Stavros with one Brigade, swung round with this Brigade as its pivot and took up a position on the Struma river, from its mouth to about Negrita, facing east. The southern portion of this line comprised the ground surrounding the Neochori Gorge through which the river Struma rushes to the sea at Cajagzi, after leaving the flat open valley in which Lake Ahinos lies. The position of the line about Neochori presented many difficulties. It was first essential that the British should command and hold Neochori bridge, in view of a possible advance. This was difficult to do from the western bank, where the hills were high and precipitous towards the river. On the other hand to cover the bridge by holding the high ground on the east of the gorge, meant having a rapid and unfordable river close behind the trenches and entailed several new bridges to ensure reliable communication. The existing bridge at Neochori was under observation and fire by the enemy, the gorge afforded bridge sites which would be difficult to hit. The eventual decision was suggested by Captain Hall, R.E.

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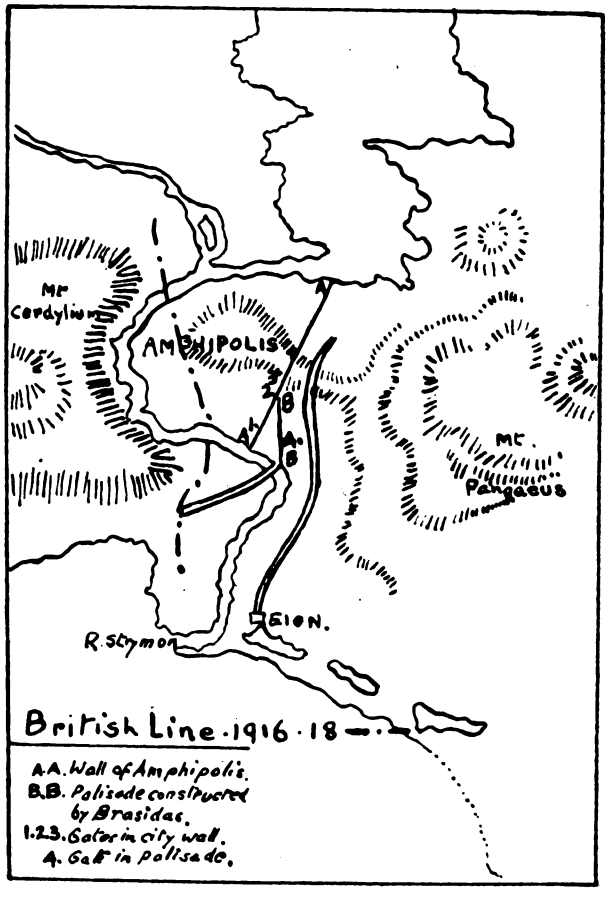
who knew the area well. This officer had great difficulty in overcoming the anxieties of the staff as regards the rapid stream and the apparent precariousness of the communications, but finally persuaded them to cross the river, to test his opinion. Once across, on the high ground east of Neochori, there remained no doubt and the Neochori Salient was decided upon. The works were dug as shown on the attached map. During the work a great number of antiquities



were discovered in the way of stones and coins, etc., as Neochori is the modern name of the ancient Amphipolis, which was the Athenian outpost on the Strymon (Struma), guarding the bridge which was on the main land route to the East.

Amphipolis was founded by Pericles about 437 B.C. The Athenians had held the mouth of the Strymon for some time but, in order to provide a better base of operations against the Edonians, on the Upper Strymon, the city was built by Hagnon on the rocky elevation that guards the river gorge from the east. Apparently defences

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were only regarded as necessary for protection from the east, as was the case in 1916 A.D., when the British occupied the ground with the same strategic object, *i.e.* to hold the road and bridge over the Struma which gave access along the coast to Mecedonia from Thrace. A reference to ancient maps shows that the sites of the British trenches coincide very closely with those of the Athenian works, after an interval of 2350 years. A striking example of the immutability of military principles.

It is interesting to trace the subsequent military history of Amphipolis. In course of the operations between the Athenians and the Spartans in Macedonia, Brasidas the Spartan commander had established himself on the eastern shores of the bay of the Strymon, (Gulf of Orphano) in the autumn of B.C. 424 and thence advanced against Amphipolis from the west. The defence of the place was in the hands of two Athenians, Eucles on land and Thucydides by sea. The former was in the town itself and the latter lay with a squadron of seven ships at Thasos. The island of Thasos was apparently considered to be in danger but there was no anxiety about the town of Amphipolis. The Spartans seem, however, to have seduced some of the inhabitants of the town from their allegiance and, at daybreak one winter morning, Brasidas and his Spartans seized the bridge over the Strymon and occupied the place. Thucydides hearing of the fall of the town hastened to Eion at the mouth of the Strymon and, occupying it, thus deprived Brasidas of the command of the mouth of the river.

In B.C. 422 Cleon, an Athenian, led a force against Amphipolis. He operated from Eion and reconnoitred the city from the hills to the East of the river and North of Eion. Brasidas by a well-timed counter blow heavily defeated this reconnaissance in force and drove the Athenians back in disorder to their ships in Eion, Cleon their commander being among the slain; Brasidas also lost his life, dying of wounds received in the action. The Athenians by various means continued to strive to regain possession of Amphipolis, until it ultimately fell in B.C. 357 into the hands of Philip of Macedonia, who held the ground, like all the rest of us, to cover the approach into his dominions from Thrace along the sea coast.

Amphipolis is also notable as the scene of the murder of Eurydice at the hands of Olympians and of the imprisonment and murder of Roxana (Widow of Alexander the Great) and her son by order of Cassander, the founder of the present town of Salonika. It seems to have been always more or less in the limelight, for Perseus, the son of the last Philip of Macedonia, fled to Amphipolis after his defeat at Pydna in B.C. 168 by the Roman L. Aemilius Paulus—Perseus subsequently fled to Samothrace when he was ultimately taken and sent by the Romans to grace Paulus' Triumph in Rome in B.C. 167.

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Salonika.—The present town of Salonika is the modern representative of the ancient Therma which stood at the head of the Thermaic gulf to which it gave its name. Therma was aggrandised by Cassander after the death of Philip of Macedonia—Cassander collected the inhabitants of the district round and put them into his new town of Thessalonika which he had named after his wife, who was a half-sister of Alexander the Great.

Thessalonika was celebrated for its amphitheatre and circus—Pliny states that it was in his time a free city and it received the distinction of a colony from the Emperor Valerian. The ancient citadel or Greek acropolis is still extant and contains what is believed to be the remains of a temple of Hercules.

Many Roman Relics also survive (1918) among them being the Arch of Marcus Aurelius and the famous Acqueduct that brings water from Hortiac Mountain to the city and from which many thousands of British troops were supplied during the occupation 1915—1918.

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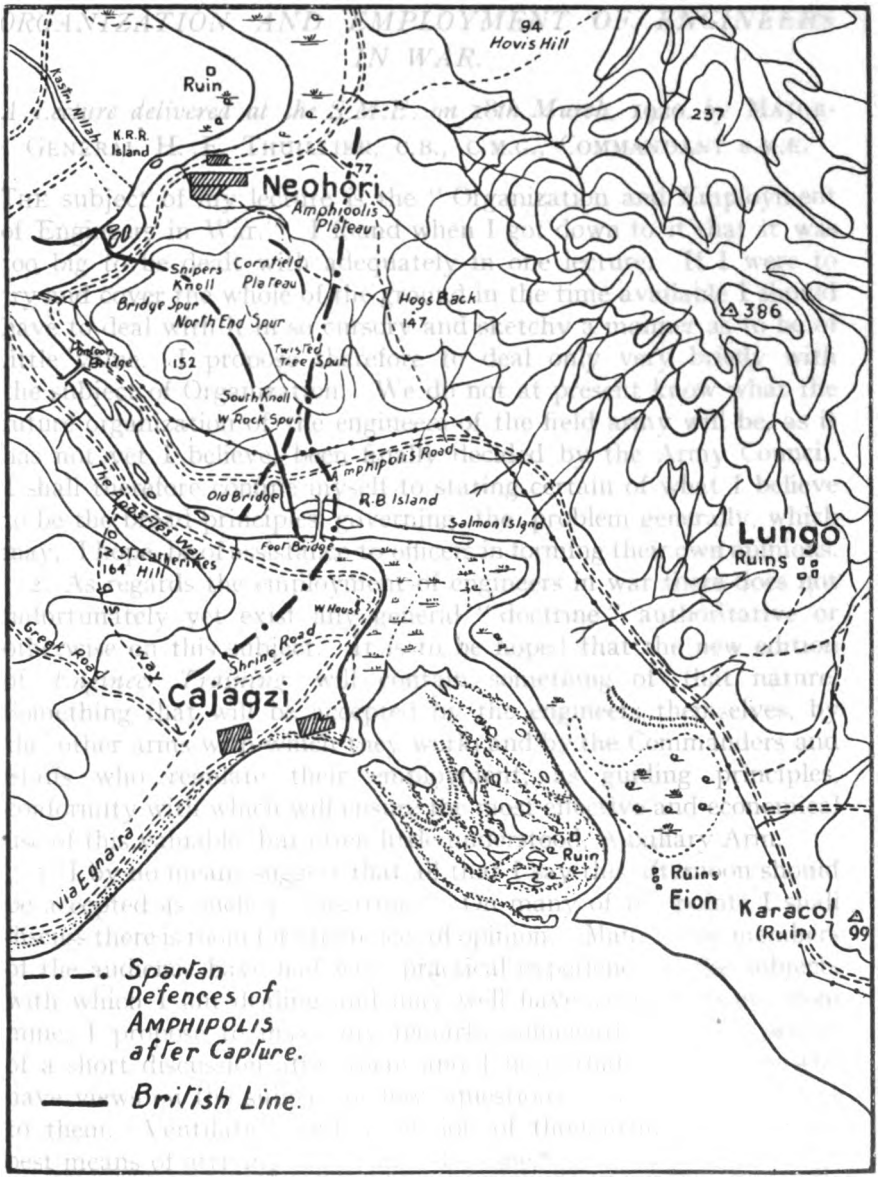

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ORGANIZATION AND EMPLOYMENT OF ENGINEERS IN WAR.

A Lecture delivered at the S.M.E. on 18th March, 1920, by MAJOR-GENERAL H. F. THUILLIER, C.B., C.M.G., COMMANDANT S.M.E.

THE subject of my lecture is the "Organization and Employment of Engineers in War." I found when I got down to it that it was too big to be dealt with adequately in one lecture. If I were to try and cover the whole of the ground in the time available I should have to deal with it in so cursory and sketchy a manner as to be of little value. I propose therefore to deal only very briefly with the subject of Organization. We do not at present know what the future organization of the engineers of the field army will be, as it has not yet I believe, been finally decided by the Army Council. I shall therefore confine myself to stating certain of what I believe to be the broad principles governing the problem generally, which may, I hope, be of assistance to officers in forming their own opinions.

2. As regards the employment of engineers in war there does not unfortunately yet exist any general "doctrine" authoritative or otherwise on this subject. It is to be hoped that the new edition of *Engineer Training* will contain something of that nature. Something that will be accepted by the engineers themselves, by the other arms with which they work, and by the Commanders and Staffs who regulate their employment, as guiding principles, conformity with which will ensure the most effective and economical use of this valuable, but often little understood, Auxiliary Arm.

3. I by no means suggest that all that I say this afternoon should be accepted as such a "doctrine." On many of the points I shall discuss there is room for differences of opinion. Many of the members of the audience have had wide practical experience of the subjects with which I am dealing and may well have views differing from mine, I propose to make my remarks sufficiently brief to permit of a short discussion after them and I hope that any officers who have views on the subject or have questions to ask will give voice to them. Ventilation and discussion of thoughtful ideas are the best means of arriving at a sound doctrine.*

*As the remarks in this paragraph which were addressed to a local audience apply to a large number of the readers of the *Royal Engineers Journal* it is hoped that any who have views on the subjects touched on in the lecture will give their brother officers the benefit of their opinions by sending them to the *Journal*.

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ORGANIZATION OF DIVISIONAL ENGINEERS.

4. As regards organization I shall be able to deal only with the engineer troops of a division. These are the basis from which the remainder of the engineer organization of an Army may be said to start. During the War the engineer work in a division, though all controlled by one man, the C.R.E., was executed by troops of three different branches of the Army, commanded and administered by a number of separate commanders. First there were the engineer companies commanded and administered by the C.R.E., secondly the pioneer battalion commanded and administered by its own C.O. and not under the C.R.E., lastly, attached to the engineer companies were working parties of infantry each taken from a unit separately commanded and administered. The defects of this arrangement are well known. There is inevitably divided responsibility with its consequent evils, and wasted effort and inefficiency owing to the real difficulties of co-operation between the engineers and casual working parties without previous experience allotted day by day to individual tasks.

DILUTION OF SKILLED LABOUR.

5. The inefficiency of the casual working party became so apparent that in the last two years of the war it became the practice to attach a party of about 100 infantry for prolonged periods to each field company in the line. The improved skill and interest displayed by parties so attached greatly improved the efficiency of the work, but the depletion of the infantry battalions and the disturbance caused in their platoon organization were serious defects, more especially in view of the fact that these attachments always took place in the period preparatory to a battle when their consequences were worst felt.

6. In view of these difficulties it is I think practically universally agreed that efficiency would be greatly furthered by having (i) all engineer and pioneer troops under one command, *i.e.*, that of the C.R.E. (ii) by having skilled labour and the semi-skilled in the same company on the principle of the artizan and his mate being trained together and working together.

7. What is meant by semi-skilled? These men may be said to represent both the class of labour of which the pioneer battalions were mostly composed and also the "attached infantry." It will be desirable naturally to have among them as many as the conditions of the labour market allow of men with some knowledge of a R.E. trade, but there will be no objection to enlisting men without a trade who will become "semi-skilled" by the special training they will get after enlistment.

8. The proportion of skilled to semi-skilled will naturally

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differ according to the class of unit. For field companies the general consensus of opinion is that skilled men should be from 25 to 30% of the whole. In Army Troops companies, E. & M. Workshops and specialist companies, the proportion of skilled men would naturally be higher.

Proportion of Engineers.

9. The next thing to consider is the total strength of the engineer troops to be provided in a division. Most engineers are agreed that the proportion existing at the end of the War, *i.e.* 3 field companies and 3 pioneer companies to a division of 9 infantry battalions was the minimum required for the conditions of position warfare. I have however heard officers of other arms express the opinion that a smaller proportion will suffice for moving warfare, though few engineers think so. Moreover the above proportion takes no account of the "attached infantry" which were always required in position warfare.

10. The actual proportion is a matter for the consideration of the General Staff and the decision of the Army Council and we do not know what will be decided. The opinions of many officers who have been asked vary from 1,600 to 2,000 of all ranks to a division of 12 battalions. I think it probable that the Army Council decision when we do hear it will be found to be nearer the lower of these figures than the higher.

Importance of the Section.

11. How should this body be organized? The foundation of the organization of any arm is the *smallest unit* commanded by an officer *i.e.* the platoon or section or troop. Although for success in war many things are necessary such as sound strategy, good generalship, well organized staff work, efficient services of supply and transport, yet when it comes to battle the ultimate issue lies in the manner in which the platoons, sections, troops do their job. This is as true of engineers as of any other arm. It is therefore correct to say that the foundation of the organization of the divisional engineers is the *Section*. The section must be of a strength and composition which is capable of carrying out a normal engineer task under a single officer. In passing I may mention that a proposal has been made to change the title of the engineer section to platoon. In the infantry, with whom engineers work more closely than with any other arm the term section has a different signification to what it has in the engineers. It means $\frac{1}{16}$ of a company, *i.e.* a Corporal's command of 10 or 12 men. To avoid possible confusion it is better to call the engineer command which corresponds to a platoon, *i.e.* the subaltern's command, by the same name. I shall however

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continue to speak of it tonight as a section as being at present more familiar.

12. The present section of a field company is 36 men, practically all tradesmen, and, as all who have commanded sections know, owing to various causes a section commander thought himself lucky if he had actually present for work over 20 men. Now when the section is composed, as is proposed, of 25% tradesmen and 75% pioneers, it is evident that it will not be capable, if it is no larger than before, of doing the ordinary job of work, owing to the insufficiency of tradesmen.

13. The majority of engineers consider that the minimum strength of a section in such circumstances should be 50, a few even advocate 70 or 75.

14. Having come to a sound decision regarding the strength of the section it will be possible to build up the organization and composition of the company and from that consider the complete organization, of the engineers of a division. Given sections of proper composition and strength an organization which in other respects is not ideal would be workable. But an ideal organization of the higher grouping, if based on weak and ineffective sections, will inevitably be a failure.

GROUPING OF COMPANIES.

15. Another crucial point is the number of companies into which the engineers of a division should be organized. If the section is not under 50, the company, of 4 sections will be 250 to 280 strong. This would give about 6 companies. Experience has shewn that 4 units is the maximum that a single commander should be required to control, and all our Army organization is based on this principle. A division into four companies would make each company too large and unwieldly. Is the alternative to group 6 companies in two battalions? When I come later to consider the methods of tactical employment of engineers it will I think be seen that an organization in two battalions will be cumbersome and awkward. Engineers are almost always used as single companies, never as battalions or groups of companies. The necessity for unity of tactical control, centred in the C.R.E., is paramount. The battalion commanders would I believe be found to be fifth wheels to the coach.

16. A suggestion has been put forward which has much to recommend it, to have the six companies grouped in three double companies, each company commanded by a Captain and the double company by a Major. This makes the double company the tactical and administrative unit, and in view of the fact that the companies will be "diluted" this would probably work well. It would give considerable elasticity in tactical working and would provide well for continuity of *liaison* with infantry brigades.

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Headquarter Company.

17. Whatever the number of companies and however they may be grouped there are strong arguments in favour of having, in addition to the field companies, a small headquarters company. It would be composed of a much higher proportion of skilled men, and some of these would be of trades which it is desirable to have for 'back' work but which are not required for work at the actual front, such as electricians, turners, moulders, draughtsmen, &c. The function of the headquarter company, which might be quite small, would be to do all the numerous small skilled jobs, manufacture of special stores, &c., which were done in the war by bleeding the field companies of their skilled men and setting up a scratch organization. It would also provide the organization and the *personnel* for dealing with engineer stores, which is very necessary.

We do not know at present what the Army Council decision on the organization of divisional engineers will be, so the preceding ideas are merely thrown out for consideration and discussion.

Functions of C.R.E.

18. The only other point in connection with organization on which I need touch is the position and functions of the C.R.E. The C.R.E. of a division has a dual rôle. In the first place he commands all the engineer units of the division and is entirely responsible for the direction and control of their work. Secondly, he is the expert adviser to the divisional commander on all engineering matters. He advises him regarding all engineer works projected or in progress, whether carried out by the engineer units or by other arms. He advises when necessary commanders of other arms regarding any engineering work that they contemplate or have been made responsible for, and he also provides them with all necessary engineer stores, but he does not control or supervise or take any responsibility for the works done by the other arms. The responsibility for their execution lies with those commanders and not with the C.R.E. More will be said on this subject, and on the duties of the C.R.E., when dealing with the employment of engineers in the field, so it is not necessary to do more now than refer to the dual nature of his functions. To assist him in these functions, which are onerous, he requires a proper Staff. This should be larger than it was in the late war, it was insufficient then and with the larger command under him in the future it will be more so. He requires a Staff Officer to assist him in the preparation of his schemes for organizing work and for issuing his orders to his units. He requires also an officer to look after the important question of provision of engineer stores. If there is a headquarter company its commander could probably fulfil this function. The

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administrative and disciplinary work in connection with his increased command will necessitate his having either a second in command to take all administrative details off his hands or failing that a second Staff Officer for the purpose.

EMPLOYMENT IN THE FIELD.

19. Engineering work in the field has to be carried out by all arms. How can the employment of the engineer units be best co-ordinated with that of the other arms in such work? Let us take the case of infantry who are more often concerned, though the principles are equally applicable to Cavalry, Artillery, Tank Corps, Machine Gun Corps or any other arm.

20. It is to be hoped that the old idea of employing engineers by distributing the individual sappers among an infantry working party to supervise their work is dead and buried. The only people who can supervise the work of the infantry working parties are the infantry officers and N.C.O's. The sapper, without the influence conferred only by military rank, can effect nothing useful in the way of supervision, and is wasted. His job is to work with his own hands.

21. Another method not unknown in the earlier stages of the War is to detail for a job of ordinary simple work requiring no technical skill such as the digging of a fire or communication trench, a section of engineers and a party of infantry. This however is also wasteful. Ask an officer who advocates this plan how he really disposes of his men. Does he distribute his little party of sappers among the infantry, *i.e.* every 5th or 6th man in a line of diggers a sapper? He will probably say, no. Does he dispose of his sappers all together at one end of the line of trench and his infantry at the other? He may say, yes. What good does that do? Why not employ instead of the 20 sappers an equal number of infantry and use the sappers for work elsewhere which the infantry cannot do? He will perhaps say that the presence of the sappers exerts some moral effect on the infantry and that without the sappers to "hold their hands" the infantry cannot set about even a simple job. Well, I don't believe that. I don't believe in the moral force generated in the infantry on the right of a line 200 or 300 yards long, on a dark night, by the presence (unknown to many of them) of a few sappers on the left. Whatever moral force they want can only be generated by their own officers. With proper training of those officers it can be and is done. It is not true to say that infantry cannot be made to do entrenching work without sappers holding their hand. It is grossly under-estimating the capacity of infantry to say so. We must get out of the habit of assuming that no one can do anything except ourselves. It is a habit which is too common and does not, I can assure you, endear us to the rest of the Army. It is also based upon error and delusion. I know from ample personal experience

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that, if the responsibility is laid on them, and proper instructions are given to them, infantry can carry out all the works that have up to now been expected of them without any engineer assistance whatever. If the after-war training in this direction is improved as much as we hope it will be they will be able to do works of much greater difficulty than those expected of them in the past. If time admitted I could give examples of the excellent work done by infantry units under my command at various times in the War.

22. The essential things are :—*to give your engineers and your infantry, separately, each their specific jobs of work and to avoid divided responsibility.* Secondly, ensure that the engineers are only employed on such work as the infantry cannot do, *i.e.* those requiring technical skill or in exceptional cases those requiring an elaborate and difficult organization.

Allocation of Responsibility.

23. In regard to the question of responsibility I should like to see it laid down as an axiom that all works in the field come under one or other of two caregories :—

(*a*).—Those for which the R.E. are responsible.

(*b*).—Those for which the infantry and other arms are responsible.

Mark that I say for which they are responsible, not merely which they execute.

24. The works for which the R.E. are responsible may be carried out by engineer units alone, or in certain special circumstances by engineer units with infantry attached for the unskilled portions of the work. They may under certain conditions be carried out by civil labour working under R.E. supervision or even by civil contract. But the essential point is that the engineer officer in charge is responsible and that the person to whom he is responsible is the C.R.E. or the senior R.E. officer with the formation.

25. Works for which the infantry are responsible will be carried out by the infantry normally without any engineers. In exceptional circumstances it may be desirable to give them a few sappers—not to supervise their work—but to do actual technical work themselves of such a nature as the infantry cannot do. Such sappers, whether with or without an engineer N.C.O. will be under the orders of the infantry officer in charge. The essential point is that in all cases of works allotted to infantry for execution the responsibility for efficient and expeditious execution lies with the infantry commander.

Duties of the C.R.E.

26. The C.R.E., as I have already stated, is the responsible adviser on all engineering matters to the divisional commander and similarly in smaller formations the senior R.E. officer present is in the same position.

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Whether the situation is one of position warfare or of moving warfare the duties of the senior engineer of any formation will be of the following nature :—

(i).—He must make himself acquainted with the intentions of the commander. He may sometimes find that this information does not flow freely or unasked from the General Staff, but it is imperative the he should seek it out and get it. This means that he must be on such terms with the Staff that they never overlook the importance of keeping him informed or that he can without offence ask outright for it at any time.

(ii).—He must obtain all possible information regarding the engineer work that is likely to be necessary for the execution of the commander's intentions, and of the labour, materials, transport, &c., which will be required to carry them out. This information he obtains from various sources, from the intelligence staff, from engineer reconnaissances by his own officers, from his own personal observations, by personal consultation with the commanders of the lower formations and units and with the staffs concerned.

(iii).—His best course then is to prepare a programme—whether the situation is one that permits of a programme looking a week ahead or only a day ahead it is always best to prepare it—shewing the works necessary in order of priority and the units or formations to be made responsible for their execution In doing this he must consult the senior general staff officer and in fact prepare it in collaboration with him.

(iv).—Lastly he must, with the general staff officer, obtain the orders of the commander of the formation on his proposals.

27. It is in this last stage that the works should be divided as I proposed previously into two categories—one of those to be entrusted to the engineers and the other of those for which the responsibility will rest with the commanders of infantry formations or units.

28. Now, as to the mode of issuing the orders for those works. In both cases the necessary orders should appear as an operation order issued by the General Staff and the order should specify who is responsible for the execution, *e.g.* the C.R.E. or such and such an infantry brigade as the case may be. It must be remembered that the C.R.E. is not a staff officer and has no authority to issue orders for works to anyone except to the engineer units under his command.

29. It should be an understood thing, preferably laid down in the standing orders of the formation, that when infantry (or other) formations or units are ordered to execute works they have to do it without any engineer troops. Needless to say only such works as they can do without such assistance should be allotted to them, similarly it is important that no work which the infantry (or other

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arms) can do by themselves is allotted to the R.E., for whom one may be certain there will be more than sufficient jobs of the type which the infantry cannot do.

30. The responsibility for carrying out the various works must be made a real one. It is useless to order works and then not to know if they are done or not. The commander responsible—whether the C.R.E. or an infantry commander—should be required to report to the General Staff of the formation when the job is completed (if it is a one or two day one) or when it is a long one, such as a long C.T. or a strong point, &c., to send in periodical reports of progress. It should be remembered that the work is an 'operation' and as in the case of every other operation a report is required of its completion or progress.

31. As soon as the decision is received as to what jobs the C.R.E. is responsible for he will issue his executive orders for their execution to his own units. He will also make the necessary arrangements for the supply of materials to the infantry formations concerned for those works for which they are responsible. He must also be prepared to give the infantry commanders any advice they may require in regard to the works they have to do—particularly as to materials, &c. He must keep in the closest touch with the changing phases of the tactical situation and be ready to produce at short notice a fresh programme of requirements to meet it and a scheme for executing this programme. For such purposes a well arranged system of *liaison* with the formations in contact with the enemy is of the highest value. Of how to secure such *liaison* I will speak later.

32. You will easily understand from what I have said, I mean those who do not know it from personal experience as many of you do, that the position of a C.R.E. of a division is no easy one. I know that many officers believe that he would find his difficulties much less if he were given higher rank and status, *i.e.* equal to that of an infantry brigade commander. No doubt it would help him, but remember that what is going to make the C.R.E. successful in his job is not an extra pip, or crossed swords or batons, on his shoulder, but that indefinable quality—one which is often present where the pips are few and sometimes absent where they are many—which we call "personality." If you can inspire confidence in your judgment and your competence in getting things done, if the commanders of the infantry and other arms know you are all out to help them on all occasions, never obstructive, not constantly producing some better plan of your own but prompt in carrying out theirs, if you are well known to everyone and welcome when you appear, if you are a *persona grata* with your commander and his staff, *then* it won't matter whether you are a Brigadier-General or a Major—you will make good.

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INFANTRY WORKING PARTIES WITH ENGINEERS.

33. I have mentioned before that in certain circumstances infantry working parties may be attached to engineer units for the unskilled portion of the work. In the future, if the engineer units contain their own dilution of semi-skilled men such occasions will seldom arise. But they may arise and when they do the question of responsibility must be clearly defined and understood by all. In such cases the engineer officer in charge is responsible for the design and execution of the work. He will give specific tasks to the officers commanding the infantry working parties and these officers are responsible for the diligence of their men and for the efficient execution of the tasks given.

PREPARATIONS FOR WORK.

34. When any work has to be carried out, whether by engineers or by infantry, it is necessary, in order to ensure its ready commencement and rapid execution, that certain preliminary arrangements are thought out and made. Otherwise confusion and delay are inevitable. These are :—

(i).—There must be a carefully prepared scheme to ensure that each unit (company, &c.) receives in good time clear and definite instructions, with sketches if necessary, as to the nature and scope of the work required.

(ii).—Rendezvous points must be carefully selected, (with due regard to the position of the tool and material dump) and notified to all concerned and provision made for " guides " who must be men with a thorough knowledge of the routes to be followed.

(iii).—There must be a well thought out organization for the ready issue of tools and materials, and definite responsibility laid on the officer in charge for the return of all tools.

(iv).—Before leaving the rendezvous clear instructions should be given to all ranks of the nature of the work to be done and the method of alignment of the party on the work. The tasks required should be explained to all ranks.

35. Task work is nearly always the best method of carrying out work. Not individual tasks, but a definite task assigned to each platoon or other party. The sooner they finish it the sooner they may go. This means that the officer in charge must estimate the amount of work it would be able to complete during the working period.

36. This is often very difficult, but it will nearly always be the best way of securing a good output. If you find that though they have been working steadily and well they cannot complete it in the time

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estimated it can be reduced. But it should never be increased even if you have under-estimated the amount they could do.

Tactical Employment of Engineer Units.

37. Broadly speaking this question resolves itself into one of whether it is best to attach individual field companies to infantry brigades and leave it to the infantry commander to use them as he pleases, or to keep them all working under the direct control of the C.R.E. Some men are in favour of the one method and some of the other and I think that their opinions are often based on the particular angle of view which their own, perhaps rather limited, experience has afforded them. Actually, no doubt, there are situations in which the one would be the best method and others where the other would be. My own opinion—and I have had opportunities of viewing the question from the angle of view of a C.R.E. and also of a brigade and divisional commander—that in the great majority of cases the large number and variety of engineer services required makes it most desirable that the C.R.E. should retain direct control of the engineer operations to the greatest possible extent in order that the work may be properly organized and the whole of the available resources in engineer *personnel* and materials made use of in the fullest degree.

The Attack.

38. Let us consider the control of engineers in the attack. In an encounter attack—which pre-supposes little or no time for preparation —it is of importance that the advanced infantry formations in contact with the enemy should be accompanied by sufficient engineers to ensure as far as possible that progress is not arrested, and that important tactical points gained during the successive phases of the attack are consolidated and fortified. In view of this it may well be advisable to attach a field company, or portion of one to the brigades making the attack. But it is also of importance that once an engineer unit is engaged on any specific work whose rapid completion is desired it should not be required to hand it over to another engineer unit. Therefore the engineer assistance required by the advanced brigades can generally best be provided by engineers being pushed forward as the situation demands from reserves in the hands of the C.R.E. that is to say by leap-frogging companies up from the rear. Close touch by the C.R.E. with the tactical situation is a prime necessity and he must use all possible means, including an organized *liaison* service, of maintaining it.

39. In the deliberate attack, there are three phases :—the preparatory phase, the assault itself and the phase following up the assault. In the preparatory phase, which, when the objective is a highly organized and strongly fortified position, may be a matter

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of several weeks, the works required are so numerous and so important that it is imperative that the engineer resources should be controlled with the utmost care so that none should be devoted to objects of minor importance. This can only be ensured by the C.R.E., in close consultation with the General Staff, exercising direct control.

40. In the actual assault it is never right to send engineers with the assaulting infantry on unspecified missions. They suffer unnecessary casualties and are unable to work when required, and their action is uncontrolled and of little value. It may often be desirable to send engineer parties to follow up the infantry with a specific mission such as consolidation of tactical points or opening up of forward communications, but their objectives should always be a specific work for which they have prepared beforehand. Even then it is undesirable that they should follow the leading waves of infantry too closely. It should be realized that they cannot do effective work on the actual advanced line occupied by the infantry in an attack. They get mixed up with the infantry, take part in the fighting, do not do the required work and suffer losses. Real consolidation can only be done when the advanced infantry line is 800 yards or so in advance of the position to be consolidated. The paramount necessity of rapidly opening up forward communications during an attack makes it of importance that the C.R.E. should retain within his immediate control as much of the engineer *personnel* as possible for this purpose, and also in order that the necessary disposition of the engineer units may be made to ensure the prompt execution of the works required in the third phase—that following the actual attack.

41. In the phase following a successful attack the conditions are in many respects similar to those of an encounter attack and the engineer units should be handled as described under that head. The infantry and artillery are pushing on to secure fresh objectives and circumstances calling for engineer assistance may develop rapidly. An organized *liaison* service is the best means of securing that this assistance may be promptly forthcoming and the C.R.E., who is in close touch through the divisional Staff with the general situation, must decide which demands must have priority at the expense of less vital ones. All engineer officers with the advanced formations must render to their immediately superior engineer commander frequent and clear reports on the engineer situation and obtain and report all possible information that would be of value.

THE DEFENCE.

42. An organized defensive system is composed :—

(i).—Of the advanced works in close contact with the enemy, which is known as the outpost zone.

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(ii).—Of the main battle position where it is intended to resist a decisive attack.

(iii).—In some cases, of one or perhaps more rear systems of defence.

The position of the outpost zone will generally be dictated by the tactical situation and will as a rule be on or near the lines on which the leading troops found themselves when stationary conditions supervened. The location of the main battle position will always be decided by the Commander of the formation.

The development of the works of the outpost zone will normally be the duty of the advanced infantry formations occupying it, but engineers may be required for such works as require technical skill.

The development of the main battle position will ordinarily be the duty of the divisional engineers with such additional working parties of other arms as may be required.

When there is in addition a rear defensive position its works will usually be undertaken by the engineers of the higher formations with the assistance of labour units or civilians.

43. There are certain principles which govern the employment of engineers in the defence. They are :—

(i).—The decision as to the order of importance of the defensive works required rests with the commander of the division or other formation holding the line. The governing factors will be the time, materials and labour available.

(ii).—The responsibility for the construction and maintenance of the defensive works in any sector of the front or outpost system rests with the commander of the troops in occupation of it and responsible for its defence.

(iii).—All troops are responsible for the execution as far as possible of their own defensive works, including obstacles, the employment of engineers being limited as far as possible to those which require technical skill or are of such magnitude and urgency as to call for special organization.

(iv).—Divided control and responsibility for work must be avoided.

(v).—Continuity in the carrying out of works is essential.

Allotment of Engineer Units.

44. From a consideration of these principles it will be found that in occupying a defensive system engineer units should be allotted to definite sectors of the defence which should, where possible correspond with the sectors allotted to the higher infantry formations, *e.g.*—brigades.

45. It will often be convenient to allot to a field company in such circumstances a dual rôle, namely (*a*) the execution of works in the

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front system, working in affiliation with the infantry brigade responsible for its defence and (*b*) the execution of works in the main system of defence under the direct control of the C.R.E.

46. This arrangement allows for a portion of the Company working on "forward" works and a portion of "back" works and permits of regular reliefs being carried out within the company, with the result that whereas the infantry formation or units occupying the area frequently change the engineer unit can be retained in the same sector for longer periods and so assist in securing the continuity of work which is essential.

POSITION WARFARE.

47. In position warfare the duties of engineers will be by no means confined to those connected with the defence of the position. They will also have numerous and varied duties under the following additional heads :—

(i).—Duties in preparation for attack.

(ii) —Duties in connection with the security, comfort and efficiency of the troops behind the line.

(iii).—Duties in connection with raids.

(iv).—Duties in connection with the development of communications of all kinds behind the line.

48. The inception, execution and control of the numerous works required under these heads, and the supply of the necessary materials, will necessitate the most careful organization and preparation on the part of the engineer commanders of the divisions and higher formations. It is of greater importance than ever to utilize to the best advantage all available *personnel* and material and to secure continuity in the policy and progress of the works. It is therefore essential that the engineer units should be under the direct control of the C.R.E. and that the latter should maintain a programme of the necessary works to be carried out by engineers and other arms and obtain the orders of the divisional commander on it on the lines described previously.

49. The progress of work may depend as much on the supply of stores as on the available resources of labour and the former may easily become the ruling factor. The railing up of stores from the base and their distribution through the Army and Corps parks to the divisional dump and thence to the sector dumps will become a matter of requiring great foresight and careful organization on the part of Chief Engineers and divisional engineer commanders.

THE RETREAT.

50. It may be thought that a forced retreat in the presence of a pursuing enemy would be an occasion when engineer units can best

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be employed in attachment to the formations in actual contact with the enemy. The rapid development of new situations that occur in such operations entail very varying and urgent demands on the engineers. The requirements may, as you know, be the demolition of bridges, the destruction of railways, water supplies, telegraphs, stores, &c., the erection of obstacles, blocking of roads, &c., the preparation of successive defensive positions, the construction of special communications and bridges to permit of withdrawal of troops, guns and transport.

51. However desirable the attachment of engineer units to infantry formations may at first sight appear this method will, even under these circumstances, generally be wasteful. A large amount of the work has in any case to be carried out under direct divisional control and even in the case of work required by the formations in contact with the enemy the C.R.E. alone is in sufficient touch with the general staff to estimate and provide for the engineer requirements of the situation as a whole by allotting units to carry it out as required.

52. The work however requires the most careful co-ordination and control under circumstances of peculiar difficulty. The movements of the engineer units will necessarily depend on the localities where the main engineer work is required and will therefore seldom correspond with the movements of the infantry formations in contact with the enemy. It is necessary for the C.R.E. to arrange for a close and effective *liaison* with these formations and thus to provide promptly for their requirements, which moreover can generally be foreseen and the necessary preparations made.

53. There are certain points which call for the special attention of the commanders of engineer units in a retreat :—

(i).—They must take special steps to keep in touch with the situation, and must act with initiative and readily assume responsibility.

(ii).—They must keep their superior engineer commanders well informed as to the situation and the progress of works and must report all information of tactical importance.

(iii).—They must be ready to respond to any call for engineer assistance, or other assistance, made on them by any other arm, on their becoming satisfied that the call is warranted and having due regard to the importance of any other orders under which they may be acting.

54. The entire success of the engineer operations during a retreat depends on the maintenance of efficient communication between the C.R.E. and the engineer units. The former must be kept informed always of the exact locality of the report centres of the engineer units. It is advisable to organize an independent and efficient engineer communication (motor despatch) service for the above

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purposes, though whenever possible use must be made of the divisional signal service to avoid unnecessary despatch work.

ENGINEER LIAISON.

55. Numerous references have been made to the necessity for a well-organized *liaison* service between the engineers and the arms towards whose assistance the engineer effort is directed. The best method of effecting this is to attach an engineer officer, whenever circumstances seem likely to require it, to the headquarters of the formation needing engineer assistance. Generally the formations will be infantry brigades but there are times when such an attachment to the headquarters of artillery formations, particularly the heavy artillery, will be of great value.

56. The main functions of this officer will be to form a close and personal link between the engineers and the formation to which he is attached. He should be the agency for furnishing the C.R.E. with early and accurate technical information regarding the engineer assistance required. He is in a position to estimate the nature and extent of the work, the tools, equipment, material, skilled and unskilled labour required, and the best method of executing the work, and for this purpose he will make the necessary engineer reconnaissances. He should be able to effect all the local preparatory measures to ensure the rapid execution of work by the Engineer parties when they arrive.

57. To the commander of the formation he will be the technical means of communication with the engineers and will also be able to furnish technical information and advice regarding works for whose execution the formation itself is responsible. It will often happen that such works, though not requiring the technical skill of engineers for their execution, are of a nature to make it desirable to have technical advice in regard to the design, method of execution, supply of materials and organization of labour. He should not however undertake any of the executive or administrative duties proper to the staffs of the formations or units composing it, such as issue of orders or supervision of work.

58. An important part of his duties, besides those already specified, is to foresee and suggest to the staff of the formation the occasions when engineer assistance will be of value and the nature of the work which the course of operations are likely to give rise to. The responsibility both for foreseeing such occasions and for asking for the assistance rests of course with the commander of the formation, but the help of an officer with technical knowledge will be of great value to him. For assistance in the above duties, particularly in the reconnaissance work, it will often be advisable to provide him with one or two specially selected N.C.O's or sappers.

59. Lastly it is of importance that the officer himself should be

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specially selected. He must have experience of what engineers can do and what infantry can do, he must also have a good military knowledge and judgment, be resourceful and gifted with iniative. His duties will often be of a delicate character requiring tact and discretion. In short, as in the case of the C.R.E., he requires to be an officer of personality. This after all is the quality which is almost more necessary to engineer officers of all ranks and grades than any other.

SUMMARY.

60. To sum up, we may say broadly that for the effective employment of engineers in war it is necessary to ensure the following :—

(i).—A close and accurate knowledge of all developments of the tactical situation.

(ii).—A thorough comprehension of the needs of the various fighting arms.

(iii).—A definite estimation of the work to be done.

(iv).—Well prepared arrangements for producing the materials and *personnel* for doing it.

These practically boil down to "*liaison*" and "organization." Having developed these an engineer commander should be able in the first place to furnish the General Staff with sound and competent advice on the engineering requirements of the operation in hand and in the second place to utilize to the best advantage all the available engineer resources to meet the varying tactical conditions.

The lecture was followed by a discussion.

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CORRESPONDENCE.

DEVELOPMENT OF THE WORKS DEPARTMENT IN MESOPOTAMIA.

To the Editor, R.E. JOURNAL.

DEAR SIR,

In the December number of the *R.E. Journal* there is a slight error with regard to the Shaiba Bund in the article on the "Development of the Works Directorate in Mesopotamia."

It is stated that the height of the bund was 6½ feet, designed to be 5½ feet above flood level. This would mean that there would be only one foot of water against the bund. The 5½ feet should read 3½ feet; the average depth of water to be contended against was 3 feet. With this depth of water the wave action is serious and difficult to deal with.

This error might have given rise to a criticism of the methods used, which appeared in *Railway Gazette* on the 26th December, entitled "War work of the R.E's" which reads as follows:—

"Some further particulars of the bridge and other excellent work done by Royal Engineers in the European War are given in the December number of their Journal. During the three months between the last advance and the armistice about 320 stock spans were erected, or nearly double the number put up during the preceding four years. Some further particulars are noted by Major F. P. Anderson, R.E., on the Houplines railway bridge. Owing to the proximity of the station, no deviation could be laid down. As the abutments were built for a double line the damaged girders for the single line were shifted, leaving space for a new super-structure in case the old one failed entirely; this did not happen, and the repairs were duly carried out. In the same issue, a full account is also given of the 40 miles of roads and many miles of flood protection works executed at Basra. The great difficulty in the way of laying down rails in the first instance, and of protecting the bunds to keep out the floods, appears to have been the absence of material for ballast and metalling, and for resisting the action of waves on the outer slopes of the bunds. Trap rock was brought from Bombay, and limestone from an island many miles off, for the roads, and a coarse sand, also brought from a great distance, was found sufficient for the latter purpose. Many buildings of brick were occupied, showing that brick burning was indigenous to the locality but the manufacture of bricks was not attempted owing to the lack of fuel. In Eastern lands garbage of all kinds is burnt in rough kilns, and coal dust is exclusively used in Bull's kilns. There must have been plenty of both kinds of fuel available with which this difficulty might have been overcome from the very beginning of operations."

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The writer of this article does not appreciate the conditions of lower Mesopotamia being a country without trees, other than date palms, and without grass and very sparcely populated ; there is no litter or garbage suitable for brick burning from the local inhabitants, and practically all litter available from military camps was utilized as fuel foi incinerators.

Bricks were burnt locally with reeds and oil fuel, but their supply was insufficient to cope with the demands for buildings and were not available for roads and revetments. Coal dust was not available in sufficient quantities to warrent its use, and it was not considered expedient to import it from India owing to the scarcity of sea tonnage. The coarse sand of which the correspondent speaks was not brought from a great distance, but was excavated from the Shaiba Ridge where the bund abuts on high ground.

Yours etc.,

D. K. EDGAR, *Colonel, R.E.*,
Director of Works.

G.H.Q. Baghdad, 4th March, 1920.

THE WORD "GADGET."

A correspondent sends the following :—" You know, in the Marines, when we can't think of the generic name for anything, we call it a 'gadget' or a 'gilguy.'" [R. G. Kauffman " Our [U.S.] Navy at Work " p. 194, quoted by C. A. Smith in " New Words Self-Defined."]

REVIEWS.

APPLIED AERODYNAMICS.

By L. BAIRSTOW, C.B.E., F.R.S. (Longmans Green Co., E.C.4.). Price 32/-.

This work will be found of great value, by designers of aircraft, as it contains much useful information ; is clearly written, and well illustrated. Mr. Bairstow is the expert adviser on this subject to the Air Ministry, and has had exceptional opportunities of studying aeronautics, both theoretically and practically. One rather unusual feature in the book is the information given about " lighter than air " craft, as most works of this kind seldom mention this subject.

In *Chapter I.*, after some introductory remarks on earlier experiments, the author gives a general account of a typical biplane, monoplane, and flying boat, explaining briefly the principal points in connection with their construction. Various types of engines are then considered, and the chapter ends, with a good description of the different classes of airships and kite-balloons. The statement that for safety it is desirable to take 40 m.p.h. as the maximum alighting velocity for aeroplanes, is interesting.

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In *Chapter II.* the general principles of flight for both aeroplanes, and " lighter than air " craft are discussed. In the aeroplane section the following points among many others are considered viz. the wings and their resistance, body and other resistances, the propulsive mechanism, etc, while climbing flight, diving and gliding are fully gone into. It is satisfactory to see that the author gives the correct explanation of " Soaring Flight," viz. : that it can only be performed in rising currents, in gusty winds, or when the wind has different velocities at different heights. Various other questions are considered, such as flight at high altitudes, variation of engine power with height, etc. In discussing the " centre of pressure " it should be noticed that the author defines this as the " point where the line of the resultant pressure cuts the chord of the section of the aeroplane " This point is taken as a matter of convenience and is not the true centre of pressure as defined by Langley. Numerous other matters are considered and there is an interesting paragraph on the effort necessary to move the elevators, the force on the pilot's hand (under the varying conditions given) being shown very clearly in Table 18. The forces acting on flying boat floats are next dealt with, and the chapter concludes with an explanation of the calculations necessary for " lighter than air " craft. There is also a useful section on the equilibrium of kite-balloons.

In *Chapter III.* there is a very good general description of the various instruments used in aerodynamical experimental work. The apparatus required for measuring the velocity, pressure, etc., of the air are described, as also the accelerometer, aerodynamic turn indicator, etc. The use of the cinema camera for recording movements of aircraft is explained and a description of the " Wind Tunnel " and the method of using it follows. The chapter concludes with a brief account of the " Water Tank " used for making experiments on the resistance of the floats, and hulls of flying boats, but no details of the apparatus known as the " Whirling Table " are given, though it is mentioned in connection with the subject of air screw testing.

Chapter IV. is a very important one, as it contains a large amount of information regarding the problems which usually arise in the aerodynamic design of aircraft. Part I. " Straight Flying " discusses the geometry of wings, their aerodynamical co-efficients of different kinds, the effect of changes in wing form, etc. A comparison between monoplanes, biplanes and triplanes follows, and the results of varying the " gap," " stagger," etc. are considered. The pressure distribution on the wings of a biplane is explained, and a comparison between the forces as estimated from the pressure distribution diagrams, and those measured directly on a balance, is made. A discussion on the resistances of various bodies such as struts, cables, radiators, engine cooling apparatus, etc. follows. The method of finding the resistance of a complete aeroplane model is then described and analysed, and it is shown that, as stated in the Advisory Committee Report dated December, 1917, the more closely the model wing tested represents that used on the full scale machine the more reliable will the results be. The description of the experiments on airships is particularly interesting, especially Table 42, which gives in detail, the resistances of the different parts of a non-rigid

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airship. Part I. concludes with a description of the pressure distribution round an airship envelope, and shows the positive pressures round the front, and the development of the negative pressures in rear. Part II. " Non-rectilinear Flight." In this a standard system of axes for flight calculations is described and the symbols used for the forces, moments, etc., are considered. The method of calculating the forces on the model of a flying boat hull is explained, as also the scheme for calculating those on an aeroplane body, with fin and rudder; the effect of the presence of the tail plane being specially considered. This Part II. concludes with the consideration of "change of direction of axes without change of origin" and describes the formulae with the equations of motion and stability.

Chapter V.—In this " aerial manœuvres " and the equations of motion are considered. " Looping " " Spinning " and " Rolling " are briefly described and the method of calculating the forces, etc., acting on a machine in such cases is given.

Chapter VI. deals with " Airscrews." The theories of " Froude " and " Drzewiecki " are first explained and it is pointed out that a combination of the two gives the best results. Experiments on the velocity and direction of the air flow, near an airscrew, carried out at the National Physical Laboratory are then considered, and the results for both stationary and moving airscrews described. A mathematical theory of the airscrew, from which expressions for the thrust, torque, etc., are deduced follows, and the author points out, as a result, that rotational inflow may be neglected, that an average value of (.35) may be used for the translational inflow, and that the final calculated results for thrust and torque are in good agreement with practice. An example of the calculations for a particular airscrew is given, the efficiency being shown to be ·825. The effect of the aeroplane itself on the performance of an airscrew is next discussed, and the chapter ends with formulae for airscrews suggested by considerations of dynamical similarity.

In *Chapter VII.* experiments on Fluid Motion are described, and the mathematical theories of aero and hydro dynamics discussed. As regards fluid motion shown experimentally, a description of the apparatus used is first given, and the results obtained by photographing the flow round a disc are shown. Steady and unsteady motion of a fluid are then described, as also the path of particles in an eddying fluid. The two standard methods of presenting fluid motion which correspond with the difference between stream lines and paths of particles, are then explained and it is pointed out that there are three distinct stages (1) steady: when forces due to viscosity are very great compared with inertia forces (2) steady; when both forces are appreciable (3) unsteady, and possibly steady: when inertia forces are large compared with those due to viscosity. The elementary mathematical theory of Fluid Motion is next considered. The " Sink and Source " system is well described and there is a particularly interesting account of Fuhrmann's arrangement of the sources and sinks, to ensure a fair shaped form. All the forms generated in this way are of course forms of " no resistance," but it might be found useful to use sinks, rather less than sources (surplus water running to infinity) and thus obtain forms which by suitably

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shaping the rear portions would be " forms of resistance," and possibly of practical utility. Cyclic and discontinuous motion are then considered and the chapter concludes with a discussion on motion in viscous fluids. It is clear that this subject requires a great deal more examination.

Chapter VIII.—In this dynamical similarity and scale effect is considered. A general explanation of the theory is first given, and its application to fluid motion explained. The law of corresponding speeds is described, and the reasons why this law cannot always be applied are given. Numerous examples follow and the conclusion arrived at is, that so far research shows that a reasonable application of model results to full sized work is justifiable.

Chapter IX.—The prediction and analysis of aeroplane performance. This chapter commences with a discussion on the effect of height on aeroplane flight. A rapid method of predicting the speed, climb, etc., is first described, and later on a more accurate method is explained. A good feature of the chapter is the calculated examples, which are always useful to students.

Chapter X. on " Stability " is divided into two parts, the first dealing with the general mathematical theory of the subject, the second with the details of the disturbed motion of an aeroplane. Part I. commences with a description of some experiments on two aeroplanes in flight, one stable, the other unstable, and the definition of a stable machine follows. The use of models for solving questions of this kind is explained, and it is pointed out that while the action of the airscrew brings new and appreciable forces into play, the general principles of stable and unstable motion are not changed. A full description of the mathematical theory of stability follows, and a number of miscellaneous questions in connection with the subject are examined. In Part II. the details of the disturbed motion of an aeroplane are discussed, and suitable formulae for calculating such details are given. The effects of gusts, etc., are considered, and a discussion on the controlled and uncontrolled flight of a stable aeroplane in a natural wind, concludes the chapter.

Appendix.—In this a new method of solving equations of the 4th and 8th degree is described. This will be found useful for the stability equations, which are often of these classes.

J. D. FULLERTON, *Colonel, R.E. (ret.)*

PAGES D'HISTOIRE, 1914—1918.

(Librarie Militaire Berger-Levrault, 5—7 Rue des Beaux Arts, Paris).

(*Continued from R.E. Journal for March*, 1920).

The 162nd number of this series is entitled *La Lutte Financière entre les Belligérants* ; the author of the volume is M. G. Cerfberr de Medelsheim, Director at the Direction Générale des Finances d'Alsace-Lorraine. M. de Medelsheim points out that the Great War was not only a military conflict, but also a contest in the fields of economics and finance. So far as certain military aspects of war were concerned,

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the Central Powers and their allies, the Bulgars and Turks, possessed an advantage over the Allies and Associated Powers; however, the weakness in their armour was finance, Germany alone had any credit worth speaking about. The National Debt of the Belligerants at the date of the outbreak of the War is set out: at that time the German debt was less than one-fifth of the French debt and equal to about one-third of the debt of the British Isles. The borrowings of the several Powers are touched upon and information is given relating to the amounts raised in the principal belligerant countries by means of each of the loans floated and the rate of interest which the several Governments had to pay for their respective loans. An interesting feature of this volume consists in the eight diagrams which show the fluctuations in the rates of exchange during the progress of the war: they afford some index of the confidence, or want of confidence, at various dates as to the supposed chances of ultimate victory falling to this or that group. Taking the Swiss franc as a standard, the depreciation of the French franc reached its low water mark in the July of 1918 (32% below par); the £ sterling was at its minimum during May and July 1918 (26% below par); the American dollar reached its minimum at the same time as the £ sterling (also 26% below par); the German mark fell to a value 50% below par in the August and November of 1917, but experienced a sharp recovery in January 1918 (28% below par), eventually reaching its low water mark in November 1918 (56% below par); the Austro-Hungarian krone followed the German mark and stood at 64% below par in August and November 1917, recovering to 46% below par in March 1918, it finally dropped to its minimum in November 1918 (68% below par).

The 163rd number contains the official communiqués issued by the Central Government to the Provincial Authorities during the period July—September, 1918; it is the XXXVIII volume of the series dealing with such matters.

The 164th number is a Diary of the War covering the period 1st July to 31st December 1918; it is the 9th volume of the series dealing with such matters.

W. A. J. O'MEARA.

NOTICES OF MAGAZINES.

LA REVUE D'ARTILLERIE.

The *R.E. Journal* has much pleasure in announcing the re-appearance, after an interval of nearly six years, of the *Revue d'Artillerie*. This event is one of more than ordinary interest in view of the noted excellence of the French Artillery during the Great War and of its high promise of further epoch-making successes. The *Revue* proposes to deal with a large range of subjects, from the scientific methods of preparation and execution of fire to metallurgy in so far as it concerns the construction of the arm. It is edited by Berger-Levrault, and may be obtained, at the annual cost of 35 fr., from *La Revue d'Artillerie* 252 Rue de Vangirard Paris XV°.

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THE MILITÄR-WOCHENBLATT.

No. 78.—" Esse Delenda " compares the fate of Carthage with that which Germany may expect if she does not devote all her energies to the restoration of her national spirit and defensive powers.

The new Army law and the struggle for German Unity.—Expresses the hope that the new Army will stand as a homogeneous force unaffected by questions of state partitions and above all by politics. Before the war the individuality allowed to the various state contingents was permissible on account of the large effectives, now however such divisions would be disastrous to the diminutive army of the new Germany.

No. 79.—The surrender of German War criminals to the Allies is the subject of the leading article. Captain Scheibe makes a frantic, but very badly expressed protest against the handing over for trial of any Germans accused of war crimes. Most of it consists of wild abuse of the allies, who, he says, having robbed Germany of all her material possessions, now wish to take away her soul. After reading Captain Scheibe, one cannot help thinking that Germany would be better without the kind of soul that he wishes to defend.

The Military Situation in South Russia.—Thanks to excellent Bolshevik leading and to the fact that the ice on the Dnieper was thick enough to allow a crossing, Denikin's forces round Kieff were defeated. The Bolsheviks are delighted at the re-capture of the rich Donetz Mineral Area, and attribute this event largely to the raids of the Red Cavalry, in which the White Cavalry was several times defeated. Belgian capitalists who had come to Donetz, to exploit the minerals, have had to clear out again. The comments of the *Militär Wochenblatt* on the situation in Russia must be exceedingly difficult to compose. On the one hand their author is always pleased to see any of the Entente or their *protégés* getting a knock, while on the other he evidently fears the Bolshevists and cannot applaud their success.

The equipment of the Polish troops on the Beresina.—A quotation from the *Times* describes this as pitiful and the *Militär-Wochenblatt* contrasts this with the abundance which Poland maintains in areas where a plebiscite is to take place.

Roll of Honour.—Reserve Infantry Regiment No. 27—105 officers and 2,557 other ranks killed excluding 13 officers and many other ranks killed serving with other units.

No. 80.—*Turning points of post-Bismarckian policy* describes the course of Germany's policy in the last 30 years, how she sought power now in the east and now overseas with varying, but on the whole satisfactory progress. Von Bülow however tried to push both programmes at once, and then came trouble after trouble, until, in 1914, Germany found herself attacked on all sides. Even in 1916, when she had practically attained her eastern aims, it was still possible, by surrendering her western ones, to save much from the wreck. The wise guiding hand of Bismarck was, however, lacking and so far from giving up any of her overseas and western ambitions she expanded them and so lost all. A last frantic attempt, made while in the act of collapse, to change her policy once more and embrace with America, the League

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of Nations, came much too late and could not even delay the bitter finale.

The Military Situation in Russia.—Anxiety is expressed regarding the fate of the flourishing German Settlements near Ekaterinoslav and on the sea of Azow, now closely threatened by, if not actually in the hands of the Bolshevists. Poland is said to be desirous of peace with Soviet Russia, but to be prevented from coming to terms by the *Entente.*

An Army Order states that the Ministry of War lays great stress on the maintenance of close personal touch with the commanders of the Army, and accordingly directs them when in Berlin on leave or duty to report to the War Office. Similarly whenever the Minister of Defence stops on a journey for more than 24 hours in a place, any senior officers, who may be present, will report to him.

A fund for the benefit of soldiers returning from the Baltic is being raised and subscriptions are invited.

No. 81.—*Education of War Orphans.*—It is estimated that 153,000 German Officers were killed or wounded during the war. Under existing conditions the education of their children presents an almost insoluble problem. The *M.W.B.* advocates the conversion of the now prohibited cadet schools into training colleges. The idea has already received powerful support from many directions. Funds are asked for.

German and French Cavalry on the Marne in 1914.—This is a comparatively impartial review of the French book entitled " Rôle de la cavallerie française à l'aile gauche de la première bataille de la Marne." The reviewer says that French and German writers both complain that their opponents would not stand and fight in the open, but withdrew to the protection of their artillery and machine guns. He attributes this not to lack of Cavalry spirit (*Reiter-geist*) but to the nature of the ground and the conditions of the fighting. Everyone admits the right of cavalry to use their mobility to get out of tight places, and the occasional weakness of individual squadrons is no proof of general worthlessness. In 1916 in Roumania, German cavalry showed that it had not lost the art of the mounted attack. If the author is a cavalry man, his pride in the enterprise, which placed the French 5th Cavalry Division in the forest of Villers-Cotterets behind two German armies, from the 8th to 10th September 1914, is understandable, but he is mistaken in his estimate of the influence its action had on the operations. Its attack on the 17th German Division, which fell chiefly on a brigade of the 24th Artillery, was quite unsuccessful and though its presence was naturally not entirely without effect, the Army Commander refused to allow himself to be disturbed thereby. In fact the only measure that appears to have been taken against it was the detachment of two batteries for the protection of the Aerodrome. The decision to break off the successful attack of the right flank of the 1st German Army was due to the, to us rather mysterious, instructions brought by Lieutenant-Colonel Hentsch, from G.H.Q. and not to the French Cavalry. The reviewer then describes the action of the German Cavalry, and maintains that they fulfilled their rôle to the last, holding the British in check in spite of the superior numbers of the latter. Finally in 1918 the brilliant

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performances of the German dismounted cavalry divisions, show that they need fear no comparison with their French comrades in arms.

Cost of the National Army.—Taking pre-war rates of exchange, the pay of various ranks of English, French and German Officers is compared as follows, in Marks.

English.

2nd Lieutenants ...	6,400—7,500	*Unmarried.*	7,880—8,960	*Married.*
Lieutenants ...	7,500—8,580	,,	8,960—10,060	,,
Captains	10,340—11,240	,,	12,440—13,340	,,
Majors	13,680—15,680	,,	15,360—17,360	,,
Lt.-Cols.	23,680	,,	24,840	,,
Generals	up to 81,055	,,	84,650	,,

French.

2nd Lts. & Lieuts.	7,212—9,930	*Unmarried.*	7,212—9,930	*Married.*
Captains ...	11,172—12,792	,,	11,172—12,792	,,
Majors	15,140—16,040	,,	15,860—16,760	,,
Generals	43,405	,,	43,405	,,

German.

2nd Lts. & Lts. ...	5022—5922	*Unmarried.*	5490—6390	*Married.*
Captains ...	7652—9304	,,	8120—9760	plus, in
Majors and Lieut. Cols. ...	10,756	,,	11,212	each case 600 Marks
Colonels	12,816	,,	13,272	for each
Generals	15,084—31,980	,,	15,540—31,980	child.

These rates are stated to be quite inadequate.

The Military Situation in South Russia.—The present population along the shores of the Black Sea is said to be embittered against Denikin on account of forced requisitions to supply the corn England has extorted in payment for a comparatively modest quantity of Munitions. The drive and impetus of the Bolshevik armies is praised.

No. 82.—The old Prussian cadet corps, founded more than 200 years ago, is now to be abolished in accordance with the conditions of the Treaty. Of the 739 Cadets who were commissioned immediately on the outbreak of war no less than 373 fell, and from Von Roon to Lettow-Vorbeck and Richthofen there is hardly a famous name which will not be found in its books.

In *The Military and Political situation of the World* the idea of an alliance with the German speaking portion of Austria is opposed, partly because Germany cannot afford to support the broken down Austrian Empire and partly on account of the alleged treachery of the ex-Emperor Karl. That France, contrary to the advice of Bismarck still clings to the idea of revenge, is deplored, but the embarrassment, which America causes her by holding back, is remarked with satisfaction. The question of conscription of the French colonial man power in North Africa, on an organised basis, as opposed to free recruiting, is discussed. France wants all possible relief from the burden of national defence, but it is pointed out that, whereas she has at home no less than 36,000 local authorities to administer conscription, in Africa with seven or eight

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times as large an area, and far worse communications, she has but 150 Military stations with which to carry conscription into effect. Remarks on the attitude of France and England towards the Bolshevists follow, with their usual mixture of satisfaction at the defeat of the *protégés* of the *Entente* and anxiety at the success of the Reds. In discussing the question of the trial of the War Criminals it is declared that those whose names are included in the list will, far from being pilloried, be honoured as having carried out their true duty to the Fatherland, an attitude of mind that scarcely pre-shadows fair trial at German hands. The true cause of Germany's present position is given as follows:—" After unparalleled victories she threw down her arms, with blind and senseless trust in the brotherhood of nations; now her enemies lay the heaviest sacrifices on her, etc., etc." The return of German prisoners is looked forward to with the consciousness that in the immense majority of cases their surrender was inevitable, but in those cases where it was not, the culprits must be prosecuted with the utmost severity.

The financial position of Officers on the active list, who wish to marry.—Hitherto such Officers have been obliged to deposit a sum, varying inversely according to their rank, as guarantee of their ability to support a wife. The *M.W.B.* hopes that this rule will be maintained in the future Army regulations, in order that the position of Officers may be kept up in proper style.

Review of the Press.—Extracts from Lord Fisher's " Records " such as " Moderation in war is madness," " The essence of war is power," etc., are quoted with much gusto, as is also his letter to *The Times* of 22nd December 1919.

No. 83.—General Von Kuhl's book " The German General Staff before and during the war " is very favourably reviewed. The author, who had 22 years' service on the Staff, and, during the war, filled some of the highest appointments, was in pre-war days Chief of the French Section of the German General Staff. A large part of the book deals with the preparations for the war. The author claims that the greater part of the estimates of the enemy's strength was correct. The French Army was not under-estimated in quality or numbers and due consideration was given to her African troops. He maintains that the opinion of the German Staff, that French discipline would not have resisted the disintegrating effects of a long retreat, would, but for the battle of the Marne, have proved to be correct. As regards Russia it was recognised that her Army had made much progress since the Russo-Japanese war and her course of action was correctly estimated. The only error was concerning the Siberian, Turkestan, and Caucasian troops who made themselves felt earlier than was expected. The General Staff had no delusions about England's entering the war and described her Army as " a small but worthy foe," though possibly lacking in skill in manœuvring, as was only to be expected. It was, however, hoped that fears of native risings would prevent her bringing many colonial troops to Europe, and this hope was falsified by events. Though it was expected that England could gradually raise a National Army, what she actually accomplished astonished not only the German Staff,

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but England herself. The value of Austro-Hungarian assistance was not over-rated and the probability of Italy joining in against England was considered very small. The second part deals, more briefly, with the General Staff during the war. Here too it was as a rule correct in its appreciation of the situation and it was just bad luck that the points concerning which it was wrong, turned out to be vital.

Roll of Honour.—Field Artillery Regiment No. 22.—48 officers and 285 other ranks killed.

No. 84.—*The situation from the point of view of the Entente in June*, 1918.—This, the Editor says, is published to show how near Germany was to her triumph and how all blame of the German Higher Command is unjustified. It consists of an extract from General Pershing's report.

Regimental Unions.—Notifications regarding these are published gratis. In this number, eleven of them appear.

Roll of Honour.—Infantry Regiment No. 72 (Thuringian) 109 officers and more than 3,150 other ranks killed.

No. 85.—*Memories of January 27th.*—Captain Scheibe bewails this anniversary of the Kaiser's birthday and sadly compares it with previous ones, then bursts into a torrent of abuse of France and particularly England, and finally finds a grain of comfort in the fact that Holland declines to surrender the Kaiser.

The Entente Forces and Germany's Army.—The writer comments on the exaggerated accounts current in France and England concerning Germany's present-day armed strength; and declares that this is so small that a further reduction will expose her to Bolshevism which will assuredly not stop at the Rhine or the English Channel.

No. 86.—*The German deployment and plan of operations in* 1914.—In this article Major Foerster discusses the preparations of the Germans and of the *Entente*. Immediately after the war of 1870 Von Moltke was convinced that Germany's greatest danger would lie in a war against both France and Russia; at the same time the possession of interior lines would indeed give her the opportunity to attack both enemies, but it would rarely be the case that she would be strong enough for this. He accordingly decided, after seeing how quickly France recovered her strength, on the offensive in the west and the defensive in the east. He hoped that within three weeks he would have so beaten the French, that they could be left to the diplomats to deal with. After the agreement with Austria, he gave up this idea and contemplated a defensive policy on a narrow front in the west, while in conjunction with Austria, he defeated Russia. Waldersee, his successor, followed the same policy, but early in the nineties von Schlieffen drew up another plan of campaign. He did not think that a successful defence could be carried out on German soil, against the ever stronger French Army, long enough to allow for the defeat of Russia, especially as this latter was also much stronger and more quickly mobilisable than ever before. He determined therefore on the offensive against France. The Belfort—Verdun line was too strong and allowed insufficient room for the immense armies that would have to be used. He therefore decided on the attack through Luxemburg and Belgium and eventually worked out a far-reaching plan whereby Paris would be invested with 13 corps, while

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the French Army would be driven back on Switzerland and the Jura mountains. Meanwhile Russia was to be held with a strategical defensive though a tactical offensive, and, if it came to the worst, the country east of the Vistula given up to her overwhelmingly superior numbers. Schlieffen's successor, the younger Von Moltke, held to the same idea in the main, but could not bring himself to agree to the possibility of a French on-rush in Alsace-Lorraine, which his hardier predecessor contemplated with equanimity. In consequence too great strength was piled on the German left flank, and when it came to the point the right wing was too weak. The difficulty of transferring troops from the left to the right was too great. The envelopment which should have followed by reason of the advance through Belgium and between Toul and Epinal failed on both flanks. Schlieffen's plan was soundly and logically thought out; it failed only in its execution. Hence the battle of the Marne.

The Military Situation in Russia gives the names of some of the most prominent Red Commanders, of whom almost all held high position in the old pre-revolution Russian Army. Among them are such names as Evert and Klembowsky. The Red Armies have reached a strength hitherto unequalled. They are said to be over 2,000,000 strong and well provided with heavy artillery, tanks and every other sort of equipment.

The *M.W.B.* gives many particulars concerning the various organisations working towards settling ex-Officers and men on the land.

Roll of Honour.—Reserve Infantry Regiment No. 111, 94 officers and 2,561 other ranks killed and missing.

L. CHENEVIX-TRENCH, *Maj.*, *R.E.*

REVUE MILITAIRE GÉNÉRALE.

November, 1919.

THE LESSONS OF CHARLEROI AND BRIEY.

In this article "A. A." who describes himself as a general "Vieux jeu," criticizes the strategy of the French General Staff at the opening of the War. Officers of his age, instructed in the principles of Napoleon, recognized that Germany could launch and maintain an attack on the French North and North-East Frontier, and, in reply to the defensive system prepared there, had organized an elaborate system of railways towards the Belgian frontier, with the camp of Malmedy as an advanced guard; also that, to avoid being caught between two fires by the intervention of Russia, it was to her interest to hurl herself against the French Army and dispose of it at the very beginning. Twenty years ago it was considered that the concentration of troops should be made sufficiently far from the frontier to ensure, under the protection of strategic advanced guards, the time and space necessary for manœuvre, the object of which would be to bring, with all forces united, a vigorous offensive against the point selected at the desired moment. A con-

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centration based on this principle seemed to be the logical result of the organization and distribution of the troops in time of peace, and more than ever dictated at the present time owing to the introduction of the new factor of mobilization, and the necessity for organizing and training the reservists after joining their units. The new school, challenging the older doctrines, laid down that it was not necessary to watch the game of the adversary, but by attacking him, to impose operations on him instead of submitting to his, a seductive doctrine, but one requiring a sufficiently considerable superiority to preserve intact the flanks of the initial offensives and to assure the lines of communication. The position of Verdun, and the Couronné of Nancy were prepared, in accordance with the older view, as strategic pivots to support the covering troops, and hold out until the retarded offensive could be launched by the striking force which was to be organized well to the rear. But the ideas of the young school were rapidly introduced into all the great general staffs. The result was a strategic deployment all along the frontier and too close to the enemy, violating all the maxims of Napoleon. Security was not assured, there was no liberty of action, no economy of force, and no striking force at hand for the decisive shock after the general engagement. Extended *a priori* in the wrong direction the line could only slowly, and too late, extend to the left, and then only with inferior strength and by leaving a dangerous gap between the 4th and 5th Armies. Consequently the enemy was able to attack a weak point with his best troops, the essential end of all strategy and tactics. This faulty disposition was afterwards abandoned, and during the retreat after the battle of Charleroi strategic advanced guards were formed, then by a judicious return to the Napoleonic doctrine (a general attack along the whole front combined with a flank attack) success was attained on the Marne which had been gravely compromised by pre-war conceptions. Still, by exaggerating the principles of the *defensive-offensive* and by a misunderstanding of the term "liberty of action" the recoil was only effected, and the offensive recaptured, when the troops were 50 kilometres to the South of Paris. The German General Staff, taught by von Moltke to rely on their superiority in material resources, made a similar mistake, attacking concentrically with forces approximately equal in strength everywhere. If they had added more weight to the head of the hammer acting through Belgium, and reduced that of the handle, it is possible that in spite of the heroic resistance of the Belgians the allied left wing might have been crushed and Paris isolated. The attack through Belgium also violated one of the principles of Napoleon which is always to keep an eye on the line of communication. The attack in fact threw us back on our reserves and all our resources, instead of separating us from them. Two lessons are to be learnt, the first is that the general conduct of a war cannot be based only on the pursuit of a preconceived ideal or of an abstract principle, but also, and principally, on the adaptation of this ideal to positive axioms and to the special case, the second is that trench warfare is only a provisional phase to be thrown aside as soon as a war of manœuvre can be adopted.

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GERMAN OPINIONS ON THE WAR.—(*Continued from the October number*).

This article (translated by M. Forget from the German by Lt. Genl. Von Freytag Loringhoven) contains nothing of much interest, but as an illustration of the German point of view the remarks on aeroplanes are reproduced. He mentions that during some of the raids by German machines places which were not fortified and were of no military importance had suffered, and although bombardment of such places was in itself reprehensible, still the limits allowed to such matters were elastic. Each new contrivance develops its own ethics, the submarine for instance. In this conflict of nations, embracing economic strife as a consequence, war inclines more and more against the enemy nation as a whole, and the principles hitherto accepted, that war is levied against its armed power alone, must now be relegated to the background.

THE EVOLUTION OF THE INTELLIGENCE SERVICE DURING THE WAR.

In 1914 a war of movement was anticipated, in which events would move so quickly that rapid decision on often inadequate data would be required of military commanders, the intelligence system was organized on this conception. The Intelligence Branch, the 2nd bureau of the General Staff, did not exist in formations below the Corps d'armeés; the Divisions had interpreters only. Maps did not exist on a larger scale than 1/80,000. After the establishment of the opposing forces in trenches the first air photographs were obtained, but were far from clear. Their value in showing the exact trace of the trenches was recognized at once; the existing maps no longer sufficed and maps on scales as large even as 1/5000 for special purposes were soon demanded, in the preparation of which photography from the air was most important. The next development was the detail with which operation orders had to be issued, exacting the most precise knowledge of the locality of the attack, and during 1917 Intelligence Branches were constituted in the Divisions, supplemented by Topographical Sections. Gradually specialists in Intelligence work were attached even to Battalions and Artillery units, whose duty it was to see that no modifications of the ground in front escaped observation and record. At the same time the Corps and Army Intelligence Branches were augmented, topographical sections were posted to Corps, with separate units for the Artillery, and similarly each Army Head Quarters branch was added to, with a supplementary unit for the Air Service. By degrees the photographs were so improved that even a machine gun recently placed in a shell hole could be identified, and accurate maps of the enemy's latest dispositions could be constantly issued to all concerned. Listening posts were also organized, and were of great assistance until their object was discovered and the use of telephones in the forward areas was discontinued. Radio-goniometry was improved until it was possible to locate the position of any wireless telegraph station, and sound, flash, and smoke ranging enabled the enemy gun emplacements to be located. An average day's arrangements for the interchange of intelligence throughout the forces is sketched, and the qualifications of a good Intelligence Officer are discussed, with some speculations as to the work still in front of the Intelligence

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Branch in keeping touch with, and applying to military purposes, the ever extending discoveries of science.

JOTTINGS.

Germany.—Remarks on the encouragement given to Germany owing to the failure of the American Senate to ratify the treaty of peace, Germany's failure to deliver the coal she agreed to supply, her dealings with the Bolsheviks and anti-Bolsheviks, her non-compliance with the clauses demanding reduction of her armed forces, her interference in Schleswig, Dantzig, and Upper Silesia, her failure to reconstruct the districts of France which she ruined, the sinking of the fleet at Scapa Flow. A long list is published of various engagements which she has failed to meet.

A. R. REYNOLDS.

REVUE MILITAIRE SUISSE.

No. 2.—February, 1920.

THE STRATEGIC POSITION OF SWITZERLAND.

The article on the above subject begun in the number of the *Revue* for January, 1920, is continued in the number under notice. Under the heading, The Campaign of 1916, Colonel Feyler discusses the question whether the strategic position of Switzerland was different in 1916 as compared with its position in the summers of 1914 and 1915. Looked at from the German standpoint, two questions arise: Would it have been more advantageous to the Germans had they, instead of launching their attack against Verdun, utilised the troops so employed for an attack *viâ* Switzerland against a more southern point of the French frontier? Given that the attack on Verdun had been determined upon, would they have gained anything by deciding to use the reserves collected to feed this attack as an army for the invasion of France, *viâ* Switzerland, in the event of the attack against Verdun not meeting with success? It would seem that at one time the French Generalissimo credited the Great General Staff with some such design and plans were worked out at the French Headquarters to counter it. It is stated that the Germans had satisfied themselves that the adoption of neither of these courses would have given them any advantage. Turning to the plans of the Western Allies, the question is asked: Would the Allies have done better to make a thrust *viâ* Switzerland rather than from the Somme? Colonel Feyler considers that on ethical grounds such a scheme was ruled completely out of Court. His final conclusion is that the events of 1916 in the Western Theatre go far to discount the theory that Swiss territory possesses any special strategic value in an European War. The Campaigns of 1917 and 1918 are next discussed. Two new elements affected the situation: the break up of the Russian Front and the position of the Italian Army. The Germans were now in a position to withdraw a part of the troops which had been fighting on the Eastern Front to reinforce their Armies in the Western Theatre; and they now had therefore a freer hand. Colonel Feyler points out that the Germans had

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more to gain by utilising their additional troops for effecting a separation of the British and French Armies, and possibly for the purpose of occupying the north coast of France, than for the purposes of an attempt to create a diversion by an advance through Switzerland. The final section treats of the morrow of the Great War; the strategic position of Switzerland in relation to the possible eventualities of the future, four in number, are discussed. The general conclusion that Colonel Feyler comes to on the subject is that the neutrality of Switzerland is of most benefit to that State on its frontiers which is acting on the defensive on the sectors contiguous thereto. This conclusion he tells us involves another: the gallant Colonel is of opinion that the extent to which it is of interest to Europe that some territory, or merely some obstacle, may, under particular circumstances, afford protection to an army is not a matter dependent on that territory or obstacle *per se*, but on the cause for which the army in question is fighting.

Notes and News.

Switzerland.—It is announced that on the 17th and 18th January last, a General Meeting of the Vaudois officers was held at Villars-sur-Ollon. Colonel Vuilleumier, the Chief of Staff of the 1st Division, presided at the meeting and there was a full programme of subjects for discussion. Colonel Sonderegger, Chief of the Swiss General Staff, addressed the meeting, choosing for his subject the modern principles governing the conduct of an action. He pointed out that troops which are not provided with the most up-to-date weapons and equipment cannot be expected successfully to fulfil their rôle in war.

Apparently some mistakes were made in the translation into French of the Report made by General Wille to the Federal Assembly; this incident has given rise to regrettable discord between the German and the French sections of the Swiss Officers. The absence of frankness in their dealings between one another is said to be the cause of the discord existing between these two groups in the Swiss Army.

Colonel Sarasin's article in the January number of the *Revue* has resulted in a public discussion in the daily press, on the question of the organisation of the Swiss Army. Two camps have naturally been formed: in one of them all those who desire a large army have taken shelter, and in the other have gathered together those who would be satisfied if effective instruction were to be given to limited cadres organised on suitable lines.

France.—A special correspondent contributes notes on points of interest relating to the French Army. He states that M. Andre Lefevre, the new War Minister, who is a mining engineer, has effected a reorganisation of the French War Office and the *conseil supérieur de la Guerre*. Marshal Pétain is now the Commander-in-Chief designate of the French Army in the eventuality of a future war, and General Buat has been nominated to occupy the position of Major-General of the General Staff under similar circumstances.

Attention is called to an interesting volume relating to the reorganisation of the French Army published under the title of *La "Nation armée" nouvelle*; the authors of the articles appearing therein are young

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officers of the regular army and have adopted the signature *Viri* as a joint *nom de plume*. They are, it is stated, very outspoken in relation to the matters on which they write.

Belgium.—A special correspondent states that M. Masson has resigned the portfolio of the War Ministry on account of ill-health. His successor M. P. E. Janson has taken up his new duties and has, it is stated, created a very favourable impression. He is taking a keen interest in the establishments set up to assist those broken in the war. An enquiry is in progress in relation to the responsibility of those who surrendered Antwerp to the Germans. There seems to be a tendency to place some of the blame for the incident on the shoulders of the then Minister of War, who is alleged to have intermeddled in matters outside his province. It is stated that the demobilisation of the temporary officers has been suspended; it would appear that many of them are claiming permanent commissions in the regular army.

Portugal.—A special correspondent points out that a difficult problem has arisen in connection with the demobilisation of the Portuguese Militia. Many of those who joined up for the war are not particularly anxious to resume their pre-war occupations; on the other hand, the State is not in a position to retain permanently the services of all the officers and men called up. It is not a matter of want of gratitude, but that of a want of funds to meet the charges which would fall on the State Treasury were the wishes of all and sundry met that is responsible for the difficulties which have arisen. The Minister of War has drawn up regulations with a view to mitigating hardship; concessions are to be made to those who accompanied expeditionary forces sent out of the homeland, and particularly to those who distinguished themselves on active service.

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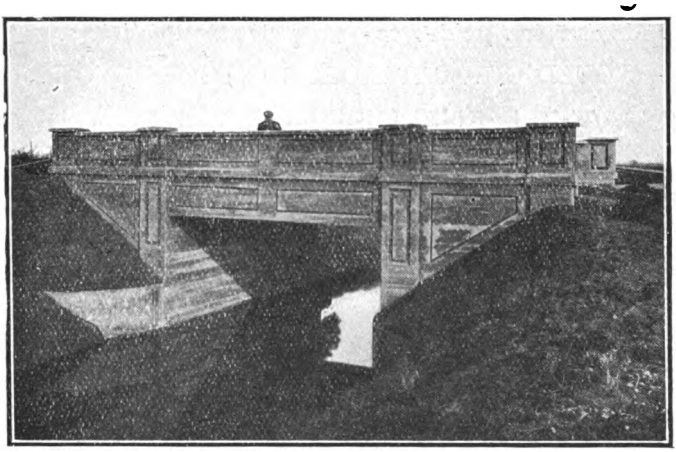

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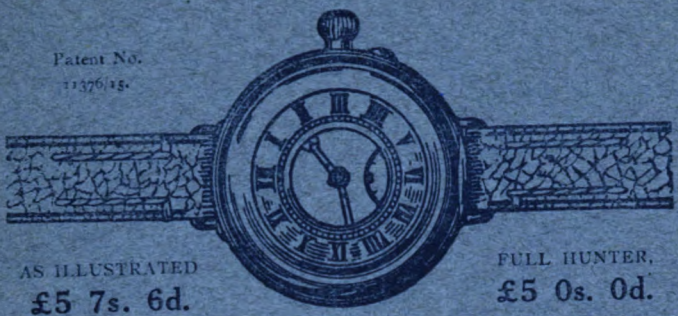

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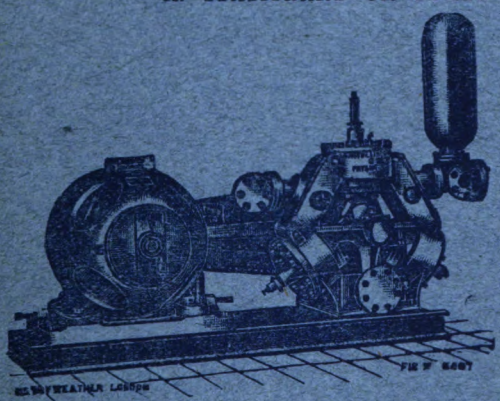

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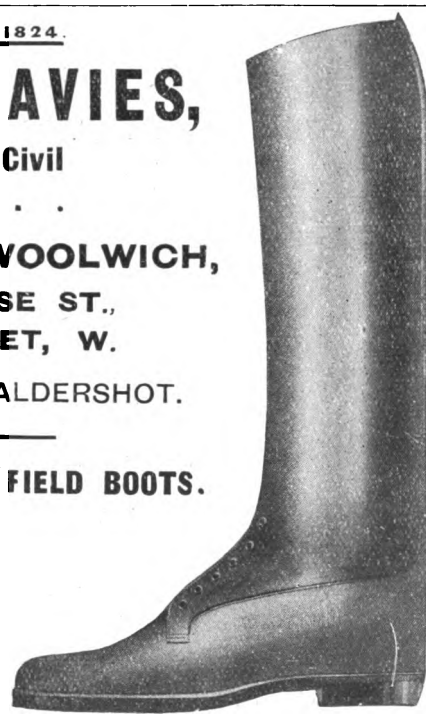

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3. The name of the recipient of the Prize shall be notified in the Corps publications; and copies of the contribution for which the Prize was awarded shall be presented to the representatives of the donors.

The following are suggested as subjects for contributions:—

(*a*). Descriptions of works actually carried out in peace or war.
(*b*). Inventions.
(*c*). Design (excluding works of defence).
(*d*). Labour organization on work.
(*e*). Scientific investigations generally.
(*f*). Accounts of exploration work and surveys.

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NOTES ON THE HISTORY AND EMPLOYMENT OF ARMY TROOPS COMPANIES, R.E.

By "BUCCANEER."

Origin.—Army Troops Companies were a creation of the Great War. In the pre-war army the only units that might be called the precursors of Army Troops Companies were the 20th and 42nd Fortress Companies, at Plymouth and Portsmouth respectively, and certain Fortress Companies abroad, such as the 24th at Malta and the 25th at Hong Kong. There were also of course, the Works Companies of the Territorial Force.

When the battle line in France and Flanders ceased to shift to and fro, and trench warfare became the order of the day, the need for more R.E. Companies to supplement the work of the Divisional R.E. was at once felt. Accordingly in the spring of 1915, eighteen new Fortress Companies numbered from 132 to 149 were gradually formed and trained at Buxton. The original intention was that six should be allotted to each army, so the 132nd to 137th Companies were called First Army Companies, 138th to 143rd Second Army and 144th to 149th Third Army. But this distinction was not of long duration as several of the first companies to proceed overseas were sent direct to Gallipoli. Besides these 18 companies, other companies were raised locally in various places—such as Tottenham, Isle of Wight, the Tees, and so on. After formation and preliminary training these latter companies were sent to Buxton for the major part of their training before going abroad.

The first six of the Buxton companies proceeded abroad in June, 1915, and the next six early in August; they all went as Fortress Companies with a total establishment of about 100. Immediately after this it was decided to change the name of the companies from Fortress to Army Troops, and a 50 % increase of establishment in men was given, and also far better transport, including two 3-ton lorries and three motor cycles with side-cars for the use of officers.

Establishment.—The original establishment of an Army Troops Company was as follows:—Captain, 1; Subalterns, 2; C.S.M., 1; C.Q.M.S., 1; Serjeants, 5; Shoeing & C.S., 1; Corporals, 7 (including 1 mounted); 2nd Corporals, 8 (including 1 mounted); Sappers & pioneers, 101; Drivers, 15 including 3 batmen. Total 142.

Attached:—R.A.M.C., 2 for water duties; Drivers A.S.C.M.T., 4 for lorries; Drivers A.S.C.H.T., 1 for 2nd line transport. Grand Total 149. This establishment includes 9 lance-corpls. (1 mtd.)

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Transport.—2 3-ton lorries, 3 G.S. Wagons (one being classed as 2nd line transport), 2 Limbered G.S. Wagons, 4 Tool carts R.E., 3 Motor cycles with side-cars, 10 Bicycles.

Animals.—2 Heavy draught horses (for 2nd line transport), 18 Light draught horses or mules, 3 Riding horses for officers, 3 Riding horses for N.C.O's.

Criticisms of establishment.—This establishment was a vast improvement over that of a Fortress Coy. The transport was immeasurably superior. Several weak points, however, revealed themselves in practice:—

(*a*).—Too few officers, taking into consideration the class of work that had to be done. Most companies actually had at least one more subaltern attached to them. See also under (*b*).

(*b*).—Too small a unit even now. As shewn below the actual working strength of dismounted men was about 100, the following necessary "duties" having to be done:—1 C.S.M., 1 C.Q.M.S., 1 Pay Serjt., 1 Orderly N.C.O., 1 Saddler, 2 Shoemakers & tailors, 2 Farriers, 1 Draughtsman (also assists Pay Serjt.), 7 Cooks and cooksmates, 1 Storeman, 4 Guard (not always necessary), 17 Mounted men. Total 39.

This leaves only 100 dismounted N.C.O's. and men actually available for works—2/3rds of the unit's strength. If the establishment were augmented, the "duties" would not increase proportionately. It is thought that an establishment of 250 to 300 would be most suitable. The mounted branch can be reduced by increasing the mechanical transport, but some horsed wagons should be retained, in some situations they are essential. The O.C. should be a major, with a captain as 2nd in command and 5 subalterns.

(*c*).—The limbered G.S. Wagons are of doubtful utility to an A.T. Coy. One may come in handy for fetching the unit's mail, or rations for a small detachment. Tool carts are really quite useless to the unit. Tradesmen always collect a few tools for their own use, and are quite prepared to carry them to and from their work. If the distance is great, a wagon can be detailed to carry the tools, which are best stored in rough chests. The solemn packing of a tool cart in the regulation way is simply a nuisance to the section sergeant. 2 G.S. wagons should take the place of the 4 tool carts.

(*d*).—A light box car or motor van and one motor cycle and side car would be better than 3 motor cycles and side cars, and more economical to maintain. The life of a motor cycle and side car under most favourable circumstances rarely exceeds 5—6 months on active service.

(*e*).—No water cart is allowed. This is really necessary.

(*f*).—The tools &c., authorized by the Mobilization Store Table were generally sound with the exception of the pile-driving gear. Heavy

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equipment of this kind is best kept at Advanced R.E. Parks and issued when required.

(*g*).—It would be better to have R.E.M.T. drivers in lieu of R.A.S.C. This helps Administration and *esprit de corps*.

Few companies ever saw the R.A.M.C. attached to them, and consequently were permitted two more sappers or pioneers in their place. An interpreter was added to the establishment and is essential for billeting &c., in moving warfare. When units were practically stationary, one with C.R.E. Corps Troops would have sufficed, and his services could have been made available for any company requiring them. By 1917, the establishment had been reduced to 143 all ranks, a few men having been taken from every company to form E. & M. Coys, and boring sections. Some good men also went to Army Tramways Cos, but these were replaced.

Training.—It was a pity that practically no information was given to the companies training at Buxton as regards the nature of work they would be expected to undertake in the field. Consequently training was carried out largely in the dark. Companies did not know whether they would be likely to be employed with Divisions or in Army Areas or on the Lines of Communication. The only thing to do was to try and make "soldiers" of the men and hope for the best. Of course tradesmen can fit in to any job.

Class of Work Done.—It may be interesting to jot down some of the more important jobs that an Army Troops Company actually did in 1916:—

Hutting (very various)
Water supply
Settling in a Corps H.Q.
Laying out and initial work on an Army Defence Line
Work on Corps Defence Line of all descriptions (dugouts, m.g. empts. wiring &c.)
O.P.'s for Field Survey Coy. and for Artillery
Preparation of positions for Heavy Artillery
Trench tramways.
Laying Decauville lines for ammunition supply to Heavy Artillery battery positions
Road screening
Running a Corps R.E. dump & workshops
Road work
Forestry work
Assistance to Field Coys. when pressed
Pipe pushing demonstrations

A somewhat varied collection!

Administration of.—For about 18 months after their first appearance in the field Army Troops Companies were very much "on

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their own." The units working in Corps and Army areas were usually administered for purposes of leave &c., by Camp Commandants of Corps and Armies, but for disciplinary purposes O's C. Coys. had the powers of C.O's. About March 1917, C.R.E's Corps Troops and Army Troops were instituted, and usually administered all R.E. Coys. in Corps Troops or Army Troops respectively. In fact the C.R.E. Corps Troops stood or should have stood in just the same relation to the Army Troops Companies working for the Corps as the C.R.E. Division stood to his Field Companies. The fact that Corps Troops are very often as strong numerically as a Division is often lost sight of. Occasionally the Commandant Corps Troops may administer as many as 28,000 all ranks.

Allotment to Corps, &c.—This being the case it is strongly urged for consideration that definite Army Troops Companies should be allotted to Corps, and *never* changed except for the most urgent reasons. It is an undoubted fact that very considerable waste of power was occasioned in the war owing to companies being shifted hither and thither from one Corps or Army to another. It is of course fully recognised that some areas, owing to their features, or the situation, required more R.E. work than others. This difficulty can be met to some extent by allotting a small reserve of companies to Armies, and these could be used for reinforcing any Corps that is hard pushed. One cannot get perfection in this respect, and quiet sectors will always have to be "bled" in all arms to reinforce a "push." Still the above principle should be adhered to as far as possible.

The question then arises of how many companies should be allotted to a Corps. Experience in the war points to two on an increased establishment as a minimum. Mining and E. and M. work would be dealt with by other units. While every company should be prepared to go anywhere and do anything, it is thought sound practice to employ one company on water supply work, another on roads and bridges, and so on, each company making a speciality of a particular class of work. This is probably better than allotting all the work in a particular area to one company. It must always be borne in mind that owing to its lorries an Army Troops Company has a wide "radius of action," as a party can always be put into a lorry or motor van with their tools and can work usefully up to a dozen miles from their headquarters. The reason why this method could not often be put into practice during the war was due to the constant shifting of companies from Corps to Corps, which it is hoped may not occur again in the future.

Name.—The name Army Troops Company has led to a great deal of misconception, and would be better altered; Corps Troops Company would be more accurate. If it is necessary to classify companies at all, (Works) Company or (Heavy) Company are suggested as

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possibilities. The Army Troops Companies, being a creation of the present war, have now practically disappeared for the moment, but it is hoped their equivalent will be preserved when things have settled down, as in any future war of any magnitude, companies of this kind will undoubtedly be required. It should be quite practicable to maintain one or two Army Troops Companies at Aldershot and other large military centres and earmark *personnel* to form cadres of other companies in the event of mobilization.

In conclusion it may be said that the normal round of an Army Troops Coy. provides probably more scope for varied engineering work than that of any other unit. With an improved establishment it would be an excellent unit to serve in.

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INTERNATIONAL COMMUNICATIONS.

By BRIG. GENERAL H. O. MANCE, C.B., C.M.G., D.S.O.
(*British Representative on the Provisional League of Nations Committee for Communications and Transit*).

AT the meeting of the Council of the League of Nations on the 18th of February, a resolution was adopted, at the instance of Senor Leon, the Spanish representative, inviting the International Commission of Enquiry on Freedom of Communications and Transit to act in an advisory capacity to the League of Nations, and particularly to prepare drafts of Conventions (international agreements) regarding transit questions, and to frame the scheme for a Permanent Organisation, which should eventually replace it, as an organ of the League.

The Organs of International Transit.—It is necessary to distinguish between the various bodies which have been concerned with international transit questions since the Armistice. First there was the "Commission of Ports, Waterways and Railways," which was part of the Peace Conference. When the work of this Commission was drawing to an end the French Government, anxious to secure continuity of collaboration by experts who had acquired a special knowledge of international problems, invited the Governments concerned to nominate these experts as their representatives on an "International Commission of Enquiry on Freedom of Communications and Transit," on which certain neutral states—Argentina, Holland, Spain and Switzerland, in the first place—as well as the Allies, were represented. This body has now, at the invitation of the League, been re-christened the "Provisional Committee for Communications and Transit" for the League of Nations; and it will, as mentioned above, be replaced by a Permanent Organisation of Transit for the League.

In an entirely separate category is the Communications Section of the Supreme Economic Council. This body deals mainly with reconstruction in Central Europe in contrast to the above-named bodies, which are more immediately concerned with matters arising out of the Peace Treaty, and with future international relations regarding Communication and Transit.

The Provisional Committee Begins Work.—The International Committee of Enquiry lost no time in giving effect to the request of the League of Nations Council. A special meeting was held on March 17th to consider the matter. M. Claveille, who was in the

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chair, in opening the sitting, thanked the Governments who had recently accepted the invitation to associate themselves with the work, now in hand, of elaborating the new Charter, which will guarantee, in the League of Nations, Freedom of Communications and of Transit to the common benefit of all. He expressed his entire confidence that the United States of America, which had participated in the Commission at its commencement through so eminent a representative as the Hon. Henry White, would not fail shortly to resume its place on the Commission.

The Commission unanimously decided to accept the invitation of the Council of the League of Nations and to consider itself, from that date, as a Provisional Committee of Communications and Transit of the League of Nations.

The Commission then examined the draft report to the Council of the League on the permanent organisation of Communications and Transit in the League of Nations which was presented by the Secretary-General in the name of the Sub-Commission of Enquiry; and after a long discussion they unanimously adopted the recommendations, which will shortly be transmitted to the Council of the League of Nations.

In addition to the above report on the permanent organisation of Communications and Transit in the League of Nations, draft International Conventions on the subjects of "Freedom of Transit," "International Rivers" and "Ports" are under consideration, and will be submitted to the Permanent Organisation for Transit as soon as the latter is constituted.

The "Provisional Committee," as at present constituted, is an essentially expert body. M. Claveille, the former French Minister of Public Works, who acts as chairman, is a man of European reputation. The other members are all public officials of high standing, Ministers, Directors of Waterways and of State Railways, and legal and other technical experts. The countries represented on the Committee at their meeting on March 17th were: Belgium, British Empire, China, Czecho-Slovakia, Denmark, France, Greece, Holland, Italy, Japan, Jugo-Slavia, Norway, Poland, Rumania, Sweden and Switzerland.

*The Need for a Liberal Régime.**—The Charter of the League of Nations in questions of Transit is to be found in Article XXIII (e) of the Covenant, by which the Member States undertake to "*make provision to secure and maintain freedom of communications or of transit, and equitable treatment for the commerce of all Members of the League.*"

* The word *régime* is used by the French in this connection in a sense slightly different from its ordinary employment in English. It implies a policy as well as an administrative system.

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It is, perhaps, not widely enough recognised how important it is to establish a liberal policy in this matter of "Freedom of Communications and Transit" from the point of view of world peace, and therefore of the League. Before the war this free régime existed, in a large measure, by general usage, and we had perhaps taken it for granted, and assumed that it would always continue. The war introduced new conditions. The needs of security and economy of rolling stock resulted in the imposition of a number of severe restrictions, which have not in all cases disappeared with the conclusion of peace.

Again, the war has created new States in which it is most desirable from the first to encourage an enlightened and uniform Communications and Transit policy, not only in their own economic interests, but to avoid conditions intolerable to their neighbours. If the members of the League recognise the importance of a liberal régime in these matters it will eliminate many potential causes of friction. It must, however, be admitted that these restrictions—vexatious though they may be—cannot all be entirely removed, at present, without inflicting hardships of another kind. The disrepair of the railways and rolling stock are so serious in some of the countries devastated by the war that Article XXIII (e) of the Covenant recognises exceptions in the interests of their own reconstruction. That is, however, a transitional state of things, and it in no way affects the principle that a liberal régime in transit questions is one of the chief interests of Europe; and hence, that the drafting of the International Conventions which are to establish such a régime is a primary need.

In addition to the general duty of encouraging Freedom of Transit, the League of Nations has specific duties laid on it by the Peace Treaties in regulating disputes as to the interpretation of the Articles of the Treaties dealing with ports, waterways and railways. The League may also, in this connection, recommend the revision of stipulations relating to a permanent administrative régime; and the Council of the League may revise certain of the stipulations at any time after five, or in some cases three years. The questions which may arise under these provisions are likely to be of a highly technical nature, and the League, therefore, needs the services of an expert advisory body.

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THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914—1919.

PART IV.

WORK IN THE FIELD UNDER OTHER BRANCHES OF THE STAFF.

SECTION 5.

METEOROLOGICAL SECTION.

Formation and Organisation.—Different Natures of Work.—Forecasts for the General Staff.—Examples of actual forecasts.—Forecasts to R.F.C.—Rules for probability of fog.—Special wind reports for Night Flying and Bombing.—Gas operations.—Information for the Artillery.—Records.

1. *Formation and Organisation.*—The Meteorological Section, R.E. was formed on September 28th, 1915, in order to develop and co-ordinate the provision of scientific meteorological measurements and of weather forecasts, whose value had been proved in the Battle of Loos.

The Section as originally constituted, included a total *personnel* of 8 officers and 28 other ranks (of whom—2 officers were held in reserve in England).

Additions were made from time to time and in 1918 the total establishment was 16 officers and 82 other ranks (including 2 officers and 7 other ranks of the detachment with the Independent Air Force) : in 1918 also a Kite Balloon Section and an Aeroplane Flight were set aside by the R.A.F. solely for meteorological work under the direction of the Commandant of the Section : and 5 officers and about 20 other ranks *personnel* were attached from the Sound Ranging Section solely for Meteor work. In the Autumn of 1918 further additions, doubling the effective strength of the Section, were recognised as necessary to meet the increased demands for meteorological information, but before the necessary arrangements were completed the Armistice was signed.

2. *Different natures of Work.*—The work of the Section falls into 5 principal divisions :—

(*a*). Forecasts for the General Staff, and for all Formations, and the preparation of memoranda in the different meteorological questions arising in the War.

(*b*). Provision of forecasts, warnings and measurements of upper wind for the Royal Air Force, and to supply any reports or statistical information needed in connection with flying operations.

(*c*). Provision of observations and forecasts in connection with

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offensive and defensive gas operations, and the preparation of memoranda on the conditions favourable for such operations.

(*d*). Provision of accurate values of wind and temperature for Artillery, due account being taken of the variations with height throughout the layers of the atmosphere traversed by shells.

(*e*). Establishment of observation posts for use in the reports referred to in (*a*)—(*d*), and for maintaining at the same time a record of the meteorological conditions in the British Army Area during the War.

3. *Forecasts for the General Staff.*—Rain was forecasted in the Battle of Loos, but at that time interest was concentrated on the wind owing to the vital importance of the latter for the use of gas in connection with the attack.

In June 1916 the importance of weather as distinct from wind was more definitely recognised, and throughout the Battle of the Somme personal advise was given regularly by telephone from the Meteorological Section Headquarters at Hesdin, and by the Meteorological Officer at Fourth Army Headquarters.

Charts were prepared daily in 1916 for the information of G.H.Q. and Armies, and from the beginning of 1917 similar charts were distributed to Corps so that Commanders could see for themselves what the general meteorological situation was, and how, in the opinion of experts, it was likely to develop during the ensuing 24 hours or more. These charts were supplementary to the ordinary forecasts sent by telegram three times daily, and normally referred to the period of 24 hours from the time of issue.

In addition to forecasts and advice about the weather of the immediate future in connection with operations, reports were also prepared of the average conditions of the different months of the year, and a set of monthly rainfall maps showing the normal distribution of rainfall in N.E. France and Flanders was made at the end of 1915, and copies of these maps were included in monthly reports subsequently issued. Copies of a section of each monthly map are attached. It may be noted that the renewal of the Battle of Ypres in September 1917, after its temporary cessation, was accelerated on account of such a report.

4. *Examples of Actual forecasts.*—A full account of the Meteorological advice given in connection with all the battles of the War would exceed the limits of space available, but the following may be noted.

July 19th, 1916.—"2 or 3 days fair weather anticipated and perhaps a week." The subsequent weather was rainless until August 9th or 10th: though the first week of the spell was mainly cloudy or overcast.

September 21st, 1916.—"Conditions on the whole favourable for fair weather continuing for 2 or 3 days."

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September 22nd.—" Fair weather likely to last over 24th."

September 24th.—" Fair weather likely to last into 26th but doubtful if it will last over 26th." Actual fair weather lasted into 27th.

October 12th, 1916.—" To-morrow will probably be better than to-day: there is just a risk of overcast skies as the type is Westerly but indications are more favourable than they have been, and there will probably be very little rain." The next day was rainless, but there was much low cloud which interfered with aeroplane cooperation.

November 8th, 1916.—" Temporarily improved and quieter weather likely."

November 9th.—" Fair weather likely to last for a day or two."

November 10th.—" Indications more favourable for fair weather continuing."

November 11th.—" Quiet rainless weather likely to last over to-morrow."

November 13th.—" Probably no appreciable rain for another 2 or 3 days, and a fine day or two likely before quiet conditions break up."

November 16th.—" Fair weather probably continuing, but a risk of rain or snow is developing."

November 17th.—" Some rain or snow likely to-morrow." Rainless but mainly overcast, misty weather lasted from the 11th to the 14th: on the 15th the weather was brighter and on the 16th and 17th cloudless. Snow came on the morning of the 18th.

April 8th, 1917.—" Strong or high winds, and unsettled weather after to-day." The subsequent week was one of changeable weather with rain, sleet and snow, and fair intervals.

April 19th.—" Ridge of high pressure developing across France will probably bring fair weather, and perhaps a spell of it."

April 20th.—" A spell of fair weather is likely with North to East Winds, and a gradually rising temperature." Fair weather lasted from April 20th to May 4th.

July 30th, 1917.—" The anticyclone is advancing slowly, and will bring better weather, but the Northerly current in front of it is likely to maintain generally overcast weather with showers, perhaps thunderstorms, at least over to-day though a short bright interval is likely towards night." On this occasion the forecasts for the 24 hours were generally correct, but the outlook beyond 24 hours was wrong. The better weather did not come until after August 4th, after 4 days of heavy rainfall in the Northern Section of the British Army Area.

September 19th, 1917.—" Conditions are not settled, and there is a risk of thunderstorms: but apart from that the weather will probably be mainly fair in the immediate future. As regards the further outlook, the indications are not very definite one way or the other,

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but as far as they go they are 10 to 9 in favour of fair weather." On the whole fair weather lasted from September 20th to October 3rd, though there was some rain on the night of September 19th—20th, and on the night of September 26th—27th: (less than 5 mm. in each case).

October 3rd, 1917. (*Morning*).—"The indications for the immediate future are not for much rain, but rather for cloud and drizzle or mist. Indications for the further outlook are against generally good weather: 10 to 8 against."

October 3rd, 5.30 *p.m.*—"Developments are not going favourably: I do not anticipate much rain before to-morrow, though the risk of it is rather bigger and high winds or gales are probable, sufficient to interfere with aeroplane work." The rainfall the next day amounted to about 6 mm.

November 18th, 1917.—"The anticyclone holds and will probably maintain rainless weather over Monday (20th). No indications yet of a break up."

November 19th—"A depression in the N.W. is moving East and spreading: it will bring unsettled weather certainly in the North of England, probably in the South, and perhaps to-morrow here too. Instead of all the indications being favourable for quiet rainless weather as they have been for the past few days, this morning about half the indications point one way and half the other, though they are still against heavy rain for the next 24 hours." The wind forecasted for dawn on Nov. 20th. was W.S.W. 8 m.p.h. Actually the mean of measurements for 5 places from Ecurie to Roisel was between W.S.W. and S.W. by W. 8½ m.p.h. The weather was overcast and misty.

November 20th, 1917.—"The deep depression of yesterday has moved to the north of Norway, and its influence here will diminish. There are no indications of immediate stormy weather, but conditions are now favourable for depressions moving East from the Atlantic to affect this area so that the continuation of rainless weather is unlikely. It will be mild." It rained at night on the 20th, and slightly during the day and night on the 21st: in all about ¼ in.

August 6th, 1918.—"The depression will probably move E.S.E. and a Northerly type set in behind it. The weather is likely to continue generally unsettled with occasional rain, and perhaps hail, during the next 24 hours, though brighter intervals are probable." Also discussed weather of August with Fourth Army Commander, and added that it was not possible then to say if there would be a new depression following the receding one: that until definite indications of a general improvement came, it was not possible to say even that we should not have a generally unsettled August."

August 7th. 9.15 *a.m.*—"Conditions favourable for fair weather for a time: unless there is a marked fall in Western Ireland on the

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next chart I think we shall probably get 2 or 3 days fair weather. I do not expect a marked fall."

August 7th, noon.—" Things look less favourable : more risk of a new depression bringing rain here : we expect generally fair weather for next 24 hours and the rain may not come at all : some indications are against its coming : the upper air has become warmer and that means that we cannot get heavy rain unless we get hot."

August 10th.—" Fair weather probably continuing over Monday (August 12th)." The weather continued fair until the night of August 16th.

November 12th.—" The anticyclone now centred over the British Isles will move further East and maintain moderate N.E. or East Winds, and generally fair weather. It will be mild in the day, but inland fog and frost are likely at night. The fair weather will probably continue at least 2 or 3 days." The weather continued fair until the 18th.

5. *Forecasts to R.F.C.*—At first reports consisted of forecasts twice daily and warnings of line squalls, *i.e.* storms which travel across the country like a wave with winds generally S.W. in front and N.W. behind. They are accompanied by a sudden rise in the barometer, a sudden fall of temperature, heavy squalls of wind, and rain or thunderstorms.

As most of the hangars faced towards the North, warnings of anticipated Northerly gales or even of a risk of Northerly gales were also issued.

The forecasts also included a statement of the anticipated direction and speed of the wind at 6,000 feet.

Early in 1916 a forecast of the anticipated amount of low cloud (cloud below 8,000 feet) in the ensuing afternoon was included in the forecasts issued in the morning to enable Squadron Commanders to make their arrangements accordingly. Arrangements were also made for the warning of all Units when thunderstorms were anticipated as they affected both aeroplanes and kite balloons, the latter even more than the former.

Warnings of fog were also issued.

The principal difficulty was to get the warnings in time to the Units concerned. For example, in August 1916 a thunderstorm warning was issued at 4.58 p.m. and a flight of 8 aeroplanes set out about 5.15 p.m. before the warning reached it. A heavy squall came up from the S.W. and 5 of the aeroplanes failed to return through it. The squall on this occasion was accompanied by thunder.

Again on August 29th, 1916, thunderstorms occurred in some places, and warnings were sent out at 3.30 p.m. From the evening chart it was seen that the stormy conditions were not over, and the following forecast was issued at 9.10 p.m. (Summer Time). " Urgent

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and Important: Wind S.E. or South 15 m.p.h., probably changing to S.W. 25 m.p.h. with gusts of gale force: but risk of a brief Northerly gale in early morning. Mainly overcast with rain squalls: improving later." The gale came later in the night, and at one place did 50,000 francs' worth of damage to hangars and aeroplanes.

6. *Rules for Probability of Fog.*—An investigation of records for Kew Observatory had shown a relation between the difference between the dry and wet bulb thermometers and the subsequent development of night fog (as distinct from drifting fog). The records in Flanders were examined and the following rules deduced :—

The readings from wet and dry bulb thermometers can be used for indicating the probability of fog at night by means of the table below. For the six months April—September the following conclusions apply to the British Army Area :—

(*i*). Considerations apply only to nights when the sky is clear or not more than half-clouded.

(*ii*). Readings taken before 9 p.m. Summer Time are not of much value.

(*iii*). If the wind at 9 p.m. is above 8 m.p.h. at 5 feet above the ground, there is little risk of fog or mist.

(*iv*). If the wind at 9 p.m. is *nil*, *i.e.* dead calm, there is considerable risk of fog or mist whatever may be the thermometer readings.

(*v*). For winds above zero and below 8 m.p.h. at 9 p.m. the risk of fog is considerable if the temperature readings give in the enclosed diagram a point which comes below the red line.

(*vi*). Fogs are about twice as frequent between 2 a.m. and dawn as they are before 2 a.m.

(*vii*). These readings do not help to foretell fog which drifts over from the sea or the south; that can only be done by means of synoptic weather charts—when it can be done at all. The readings help only in the case of fogs which develop through the cooling of the lower air by radiation at night.

At 9 p.m. (Summer Time).

Dry bulb in degrees F.	Dry bulb minus Wet bulb in degrees & tenths.	Remarks.
40	0·8	Considerable risk of fog if the observed difference dry minus wet is less than the corresponding difference in this table.
45	1·1	
50	1·4	
55	1·8	Small risk of fog if the actual difference is greater than the corresponding difference in this table.
60	2·1	
65	2·5	

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At 9 p.m. (Summer Time).

Dry bulb in degrees F.	Dry bulb minus Wet bulb in degrees & tenths.	Remarks.
70	2·9	*Example* 1.—At 9 p.m. sky nearly clear. Wind 5 m.p.h. Dry bulb 54°·6. Wet bulb 53°·4. Difference 1°·2. Difference from table for dry bulb 55 is 1°·8. Therefore as actual difference is less than tabular difference and wind is light and sky clear there is considerable risk of fog developing. *Example* 2.—At 9 p.m. sky clear. Wind 12 m.p.h. Practically no risk of mist or fog, wind too strong. *Example* 3.—Sky half clouded. Wind 4 m.p.h. Dry bulb 58°·3. Wet bulb 53°·7. Difference 4°·6. This is well above the tabular difference and there is little risk of fog.

7. *Special Wind Reports for Night flying and Bombing.*—With the development of night flying it became necessary to navigate aeroplanes by compass, and due allowance had to be made for the wind at the height at which the flight was made. Reports of wind for this purpose began to be sent to night-flying squadrons in August 1917, and continued until the end of the War. They came to be known as "Sleep-wind Reports." They were obtained in the same way as the winds for the Artillery, by the use of pilot balloons, and in fact the observations for the hours common to both sets of reports served both purposes.

Some indication of the accuracy with which the average wind over distances up to 50 miles can be obtained is furnished incidentally by quite a different operation which was carried out in June 1918. A man-carrying balloon started from near Verdun and landed at Grosbous near Luxembourg, 50 miles away in a direction N.29°E.: the forecasted wind at 3,500 feet based on pilot balloon observations was S.30°W., *i.e.* the balloon drifted to within 1° of the forecasted direction.

It is therefore clear that for night flights over short distances there need be no error due to the wind if pilot balloon ascents are possible to the height at which the flight will be made, and if they are coordinated and due allowance made by an expert meteorologist for impending changes.

With the development of night flying it also became necessary to issue special forecasts for short periods to enable the night flying squadrons to take advantage of all favourable opportunities and to avoid sending out the aeroplanes when fog, low cloud or storms are likely to develop before the completion of the raid. At first a special forecast was issued by priority telegram about 5 p.m. but in

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1918 it was arranged to issue forecasts in code by wireless at 5 p.m. and 7 p.m. These forecasts combined with the 'sleep-wind' reports, and combined too with the personal advice of Meteorological Officers given by telephone direct to the Squadron Commander contributed considerably to the success of the night bombing operations, and the comparative freedom of the night flying squadrons from untoward accidents.

As day bombing developed too during 1918 arrangements were made for issuing regularly 3 or 4 times each day reports of the wind at greater heights up to 20,000 feet. Direct observations were often not possible to that height but on such occasions the Meteorological expert at Headquarters is in a much better position than the local Unit Commander to estimate from charts and from the information available for England and France what the wind at the greater altitudes will be.

As the wind at 15,000 or 20,000 feet may reach 70 or 80 miles per hour when the wind at the surface or at 1,000 feet above it is only 20 to 30 m.p.h., it is readily recognised how important a knowledge of the upper wind is both for estimating the distance which the aeroplane can fly and return in the time available, and for enabling bombs to be dropped from great altitudes with reasonable prospect of falling near the targets.

NOTE.—If an aeroplane speed is V miles per hour, and the speed of the wind is W miles per hour in the same direction as the objective, then a total time t hours is available for going and returning and the distance which can be reached is—

$$t\ (V^2-W^2)/2V.$$

For example if $V = 100$ m.p.h.
$W = 0$.
$t = 4$ hours.
then— $d = 200$ miles,
but if instead of being zero, $W = 70$ m.p.h.
$d = 102$ miles,

or just about half the distance for no wind.

It is of course, a matter of indifference whether the wind is with the pilot on his outward or on his return journey, if the flight is made at one height. But if the flight can be made at different heights going and returning, advantage can be taken of this.

8. *Gas operations.*—In gas operations, meteorological advice is essential if the operations are (1) to be carried through without avoidable risk to our own troops (2) to secure maximum effectiveness.

The advice given is based partly on general charts which indicate the general changes likely to occur in the wind for a period of about 24 hours, and partly on local observations and a knowledge of the orography of the region concerned.

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Meteorological advice for offensive gas operations was first given in connection with the Battle of Loos in September 1915. Prior to the battle a forecast based upon the general chart of observations at 1 p.m. had been made each afternoon about 6.30 p.m. stating whether the wind next morning would be favourable or unfavourable: and the degree of confidence of the forecast had also been indicated; the forecast was corrected or confirmed about 9 p.m. by another based on the chart of 6 p.m. observations.

In the afternoon of September 24th, 1915 the indications were rather for a wind on the unfavourable side of the limiting direction; although the changes expected would be generally towards the favourable; "just a chance" expressed things briefly.

The later chart was much more favourable for the change to a favourable direction to come in time. Actually the wind changed to West in the night of the 24th—25th September but backed again to S.W. after midnight, and after 8 a.m. changed to south and slightly to the east of south.

Gas attacks in 1915—1916 were made chiefly by discharging cylinders so that the gas started on its course from our own lines. This naturally involved more risk of accidents and a steady wind was required to ensure the gas getting away without temporary eddies back to our trenches. It also made it very difficult to have gas attacks in connection with pre-arranged operations.

With the system of projectors used subsequently much lighter winds could be used: the culminating point being reached in March 1918, when projectors were discharged on Third Army front with a generally unfavourable wind which was turned into a calm or slight favourable wind by the gravitational effect of the night cooling on the eastern side of the Boulogne—St. Quentin Ridge.

During 1917—1918 also gas shelling was much used, and special forecasts were made each afternoon and evening to indicate what the wind conditions would be near the surface at 7 p.m., midnight and 4 a.m.

On occasions too, cylinders were run up in railway trucks and discharged without being unloaded, the forward trenches being cleared for the discharges. For such cases a steady wind was required rather stronger than for the earlier less intense discharge. On one occasion in 1918, 6,000 cylinders, 190 tons, were discharged in a single night on First Army front.

Early in 1918 too, statistical reports were prepared at the request of the Director of Gas Services for the information of the Ministry of Munitions.

Already in 1916 diagrams had been prepared showing for each month of the year the frequency of winds from different points of the compass, the winds selected being those above 4 and under 15 m.p.h. These diagrams were printed on the back of the daily

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weather charts. Similar diagrams were prepared for 1915—1917 and tables showing the number of spells of favourable and unfavourable winds lasting for 2 days, 3 days, 4 days, up to 9 days. The tables were accompanied by diagrams and notes explaining the conditions under which favourable winds occurred and the method by which these conditions were foreseen.

9. *Information for the Artillery.*—The wind for the Artillery has been obtained primarily by the observation of small free balloons ascending at a known rate. The altitude and azimuth of the balloon is read every minute and the position of the balloon calculated therefrom. The horizontal drift gives the wind in the layer passed through. For occasions when the weather does not permit of observation, the wind is computed from the general charts of pressure distribution, allowance being made for the effect of the distribution of temperature on the normal wind arising from the distribution of pressure; this allowance is estimated from the general charts, as the temperature distribution at different heights is rarely known with sufficient detail to permit of routine numerical calculation. The motion of the clouds is also taken into account.

In 1918 supplementary methods were used.

(*a*). Observations from a kite balloon: the importance of making wind measurements at a distance below the balloon greater than its diameter was established in these observations.

(*b*). Observations of the drift of smoke bursts from anti-aircraft shells bursting at known heights. The drift is observed in a mirror and a simple calculation gives the wind at the height of the burst.

(*c*). Observations of the drift of balloons rising at a known rate and carrying charges bursting at known times. The observation is made by sound ranging on the burst. This method is due to the French Military Meteorological Service.

Initially the winds at different heights were telegraphed to the Artillery, but as the total effect of the wind on a shell is a complex sum of the winds at all heights up to the top of the trajectory it was arranged in January 1917 that the necessary computation should be made by the Meteorological Section—all trajectories with the same time of flight have also approximately the same weight, and approximately also the same effective wind—the winds issued by the Meteorological Section were computed for a series of times of flight, at first up to 50 seconds and later up to 70 seconds.

Improvements in the fundamental constants, on which the computations are based, were made in 1918, and for centrally issued information applicable to varied guns and ranges the method now in use leaves little to be desired. But ultimately improvements will be effected by each battery using its own fundamental constants

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and computing the effective wind from the actual wind in the different layers. This will permit of allowance being made for the two principal effects at present disregarded, viz. the difference between the fundamental constants for cross winds and head winds, and the effect of the change in the position of the " velocity of sound region."

Put briefly the present practice is for the meteorologist to perform essentially Artillery computations on the results of his meteorological observations. The ideal plan would be for the meteorologist to confine himself to the meteorology, and leave the Artillery *personnel* to deal with all the Artillery computations.

Temperature.—The fundamental values are obtained partly from Aeroplane and Kite Balloon observations, and partly by estimation taking into account the results of experience, and the well established physical conditions governing the rate of decrease of temperature with height in a turbulent atmosphere.

The values of the temperature at different heights are used by the meteorologist to compute equivalent temperatures for different times of flight, directly applicable by the Artillery to the range tables.

In computing the approximate temperature allowance is made for the effect of temperature on the pressure at different heights; this was done in France in July 1917, and is believed to have been the first application of this method in any of the Allied Armies. It simplifies very much the application of the meteorological facts.

Barometer.—As this varies rapidly with height and in a definite way, the scientific method is to use an instrument at the battery or group headquarters. The aneroid barometer is quite suitable for all practical purposes if it is properly treated, and is compared regularly with the corrected values of a mercury barometer. If readings of the aneroid are taken at fixed times the height above M.S.L. noted, and the results forwarded to a meteorological headquarters, the comparison can be made with the usual charts of pressure distribution. This method was used for some time, but was ultimately replaced by the existing practice which is for the mean sea level value of the barometer to be furnished every 4 hours in the Meteor telegram, and for the batteries to deduce the value appropriate for their shooting by the approximate rule: " If the height of the battery above mean sea level is ' Z ' metres, then $\frac{Z}{3}$ is the number of hundredths of an inch to be subtracted from the sea level value of the barometer to give the value at battery level."

The actual practice of the meteorologist at Army H.Q. is to correct his barometer reading for the average diurnal variation to get a value applicable 3 hours later: and he superposes on that any changes in time which he anticipates from his charts and barograph.

Information as to the upper wind was also supplied regularly to

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Sound-ranging Sections from the beginning of 1917: this was practically discontinued temporarily at the beginning of 1918 owing to the establishment of special wind sections for sound-ranging purposes. But after the German offensive in March, 1918, the practice was resumed and hourly reports were issued whenever conditions were favourable for sound-ranging. Values of temperature were also added because the effect of temperature upon the "location" of a gun deduced from the sound-ranging records, though considerably less than that of wind, is still appreciable.

Experience in 1918 showed that by a proper use of the meteor values, results could be obtained as accurate as those found by the use of the special Sound-ranging wind sections.

It should be added that the proper use of meteor values for sound-ranging was due to the work of the "Wind Sections" of the Field Survey Battalions R.E. Without the large amount of data collected by these Sections it is probable that we should still be ignorant of many facts affecting the *effective* wind and temperature as regards the behaviour of sound waves.

10. *Records*—In the Summer of 1915 regular observations were made 6 times daily at St. Omer of barometer, wind, temperature, weather and humidity: rainfall was measured twice daily.

At the forward stations the observations were at first only of wind and weather but barometers and thermometers and rainguages were placed at 3 selected places and gradually the number of places with thermometers and raingauges was increased to give a more accurate representation of the variations over the area occupied by the Armies.

The results of the observations at the four principal hours 1 a.m., 7 a.m., 1 p.m., 6 p.m. were charted daily, and these charts constitute a readily accessible source for information about the wind and weather.

As time went on the number of reports was increased and information about the form of cloud, the amount of cloud, the visibility and the humidity was included for approximately every two hours day and night. Also the whole of the information was used in the preparation of a brief statement of the wind and weather of each day in the form of a weather diary. This diary was supplemented by tables giving detailed values of temperature and rainfall and was issued at the end of each month.

Pilot balloon ascents also became more numerous, and the records of these constitute a valuable source of information for all researches into the conditions prevailing in the upper air.

In addition to the use of the records for reference and research, they were also used from time to time for the supply of information as to rainfall for the guidance of those in charge of mining operations: for information about frost and its effect, in conjunction with wind,

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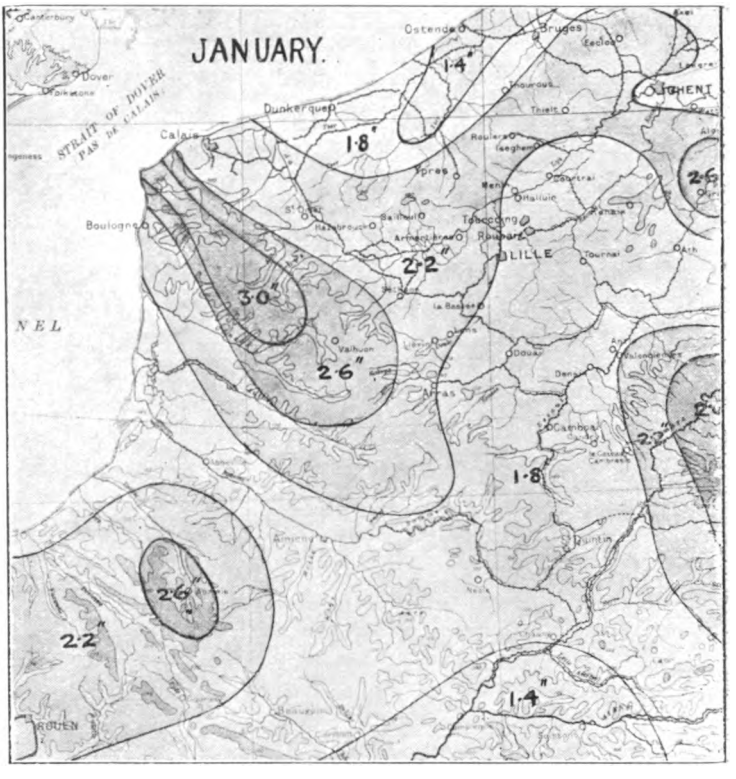

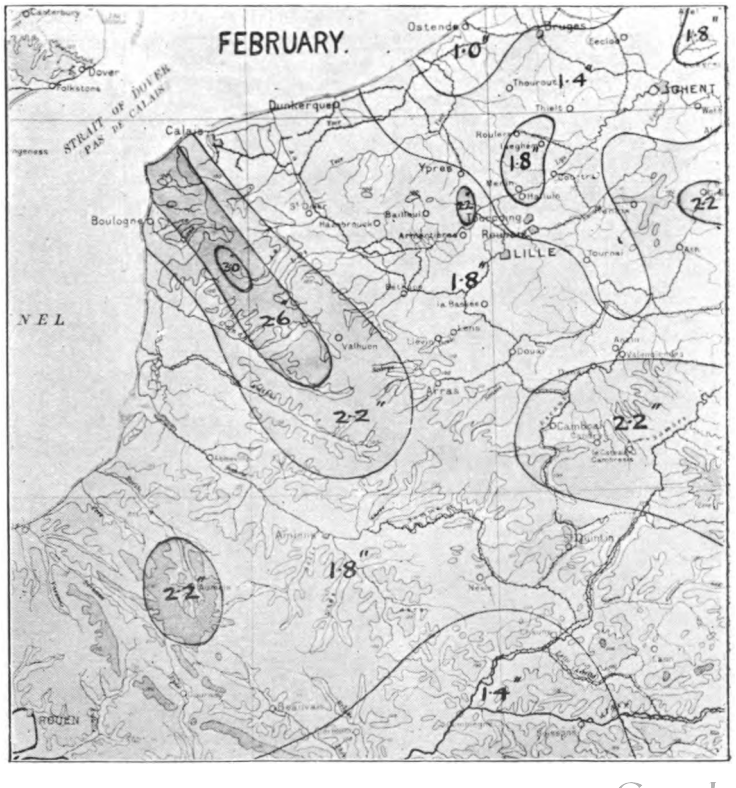

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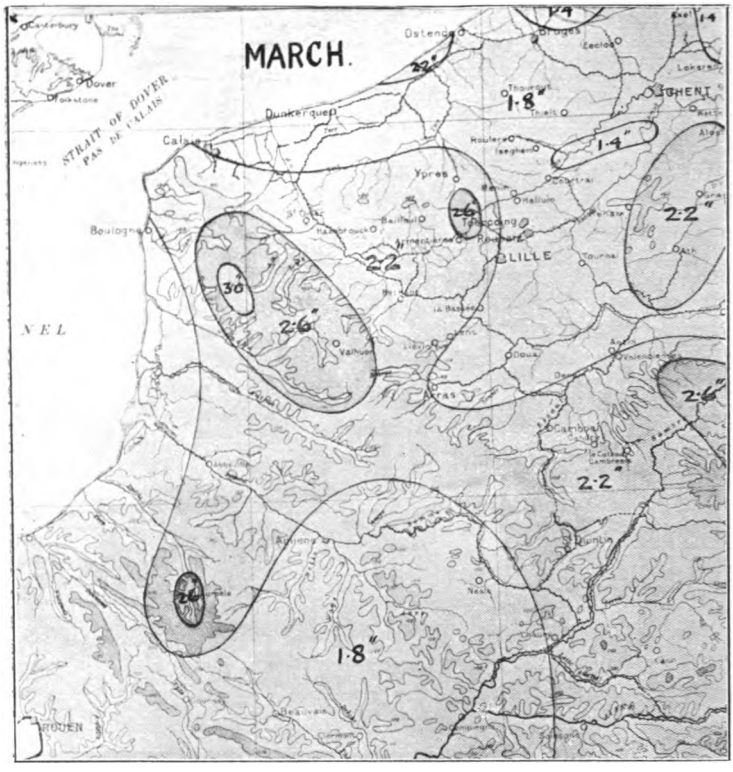

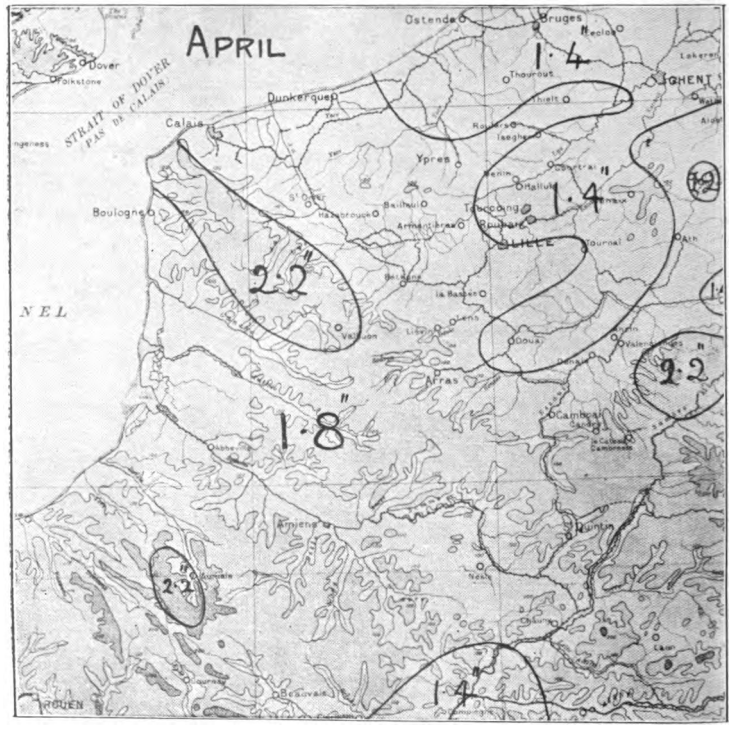

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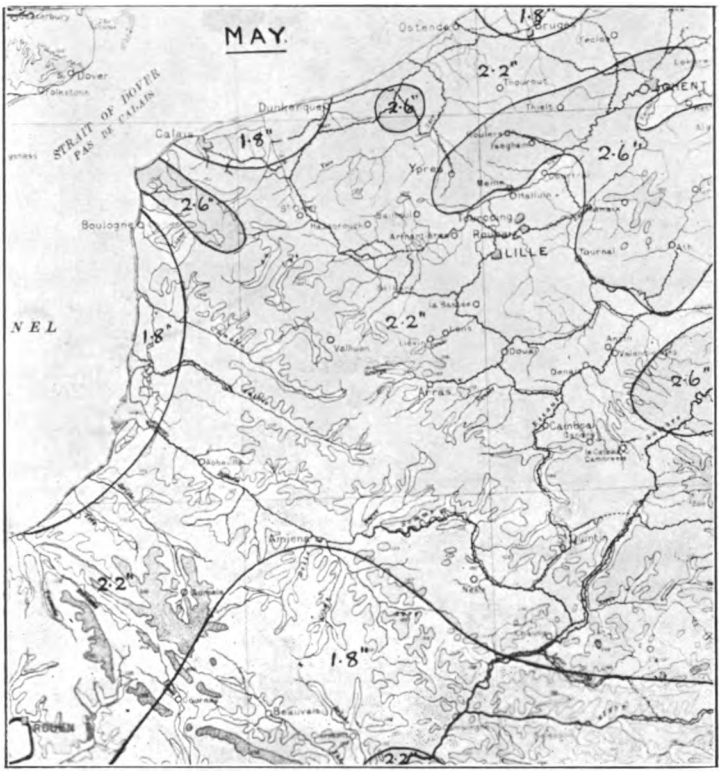

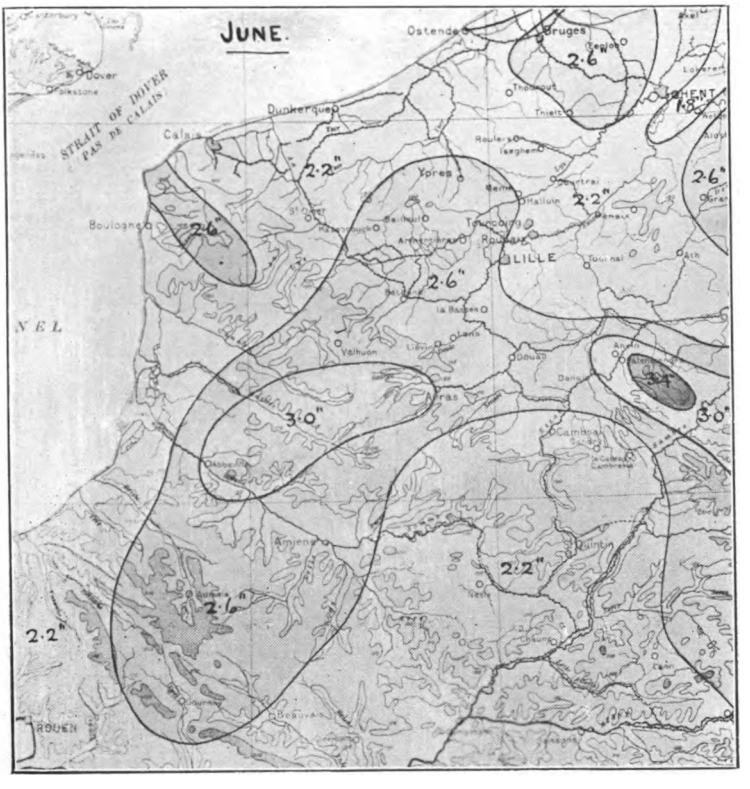

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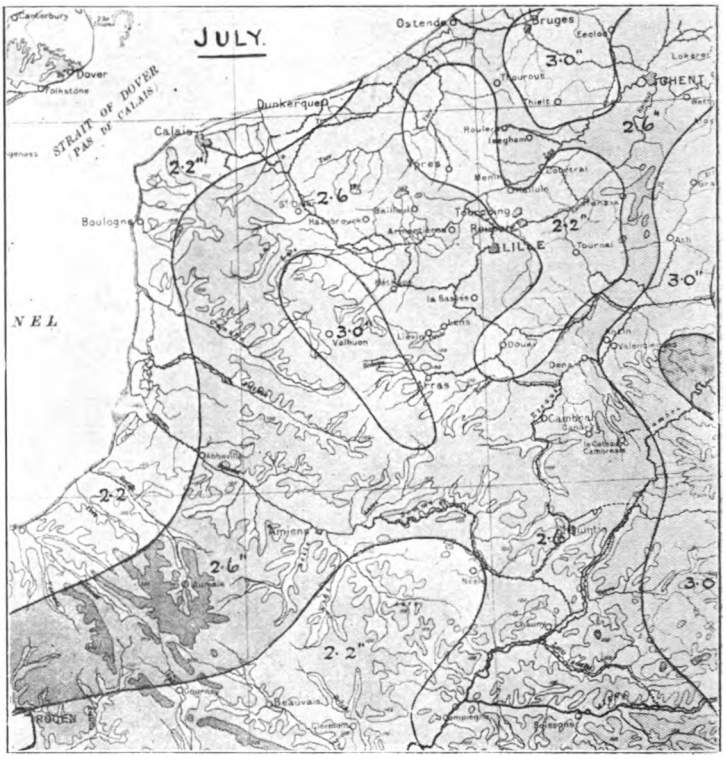

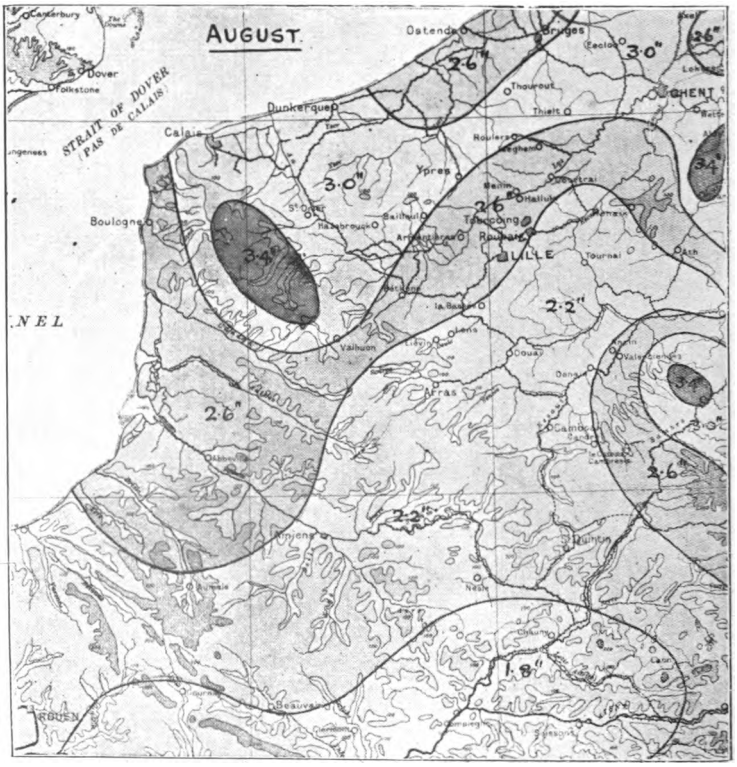

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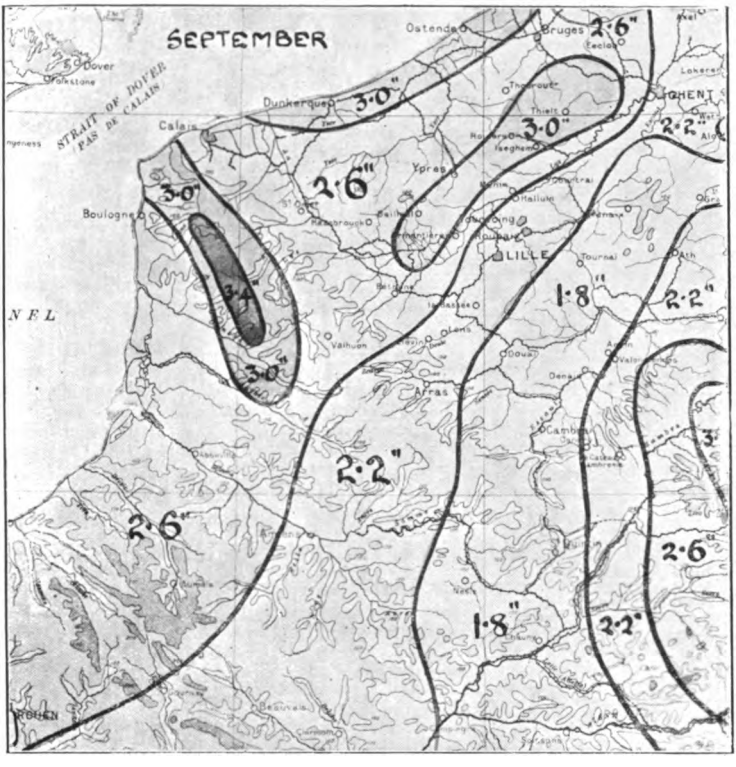

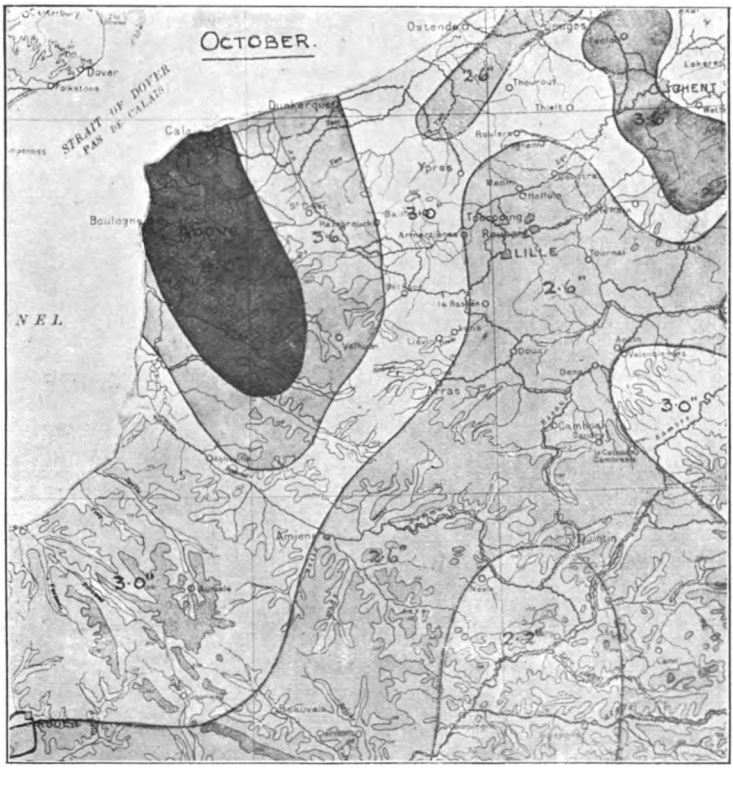

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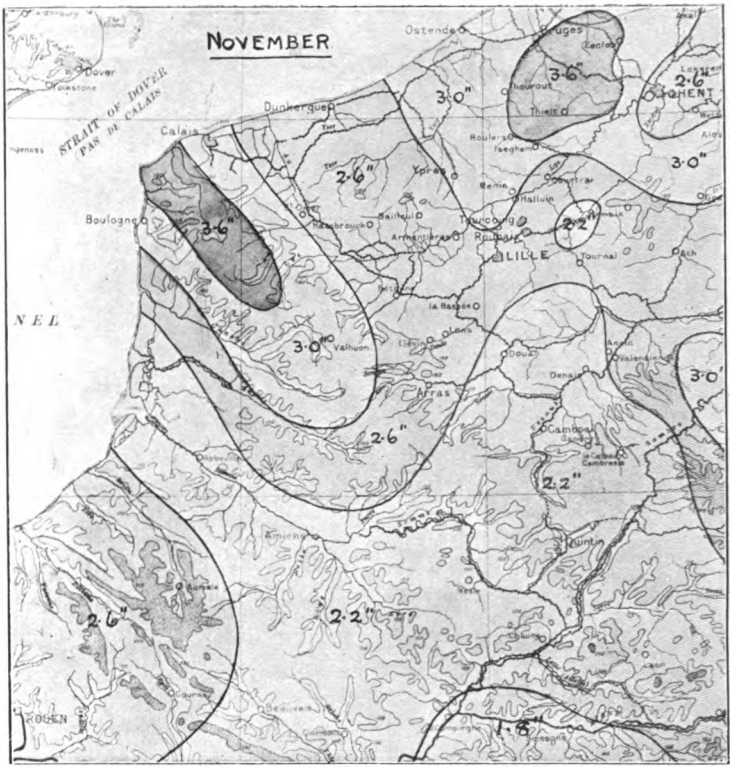

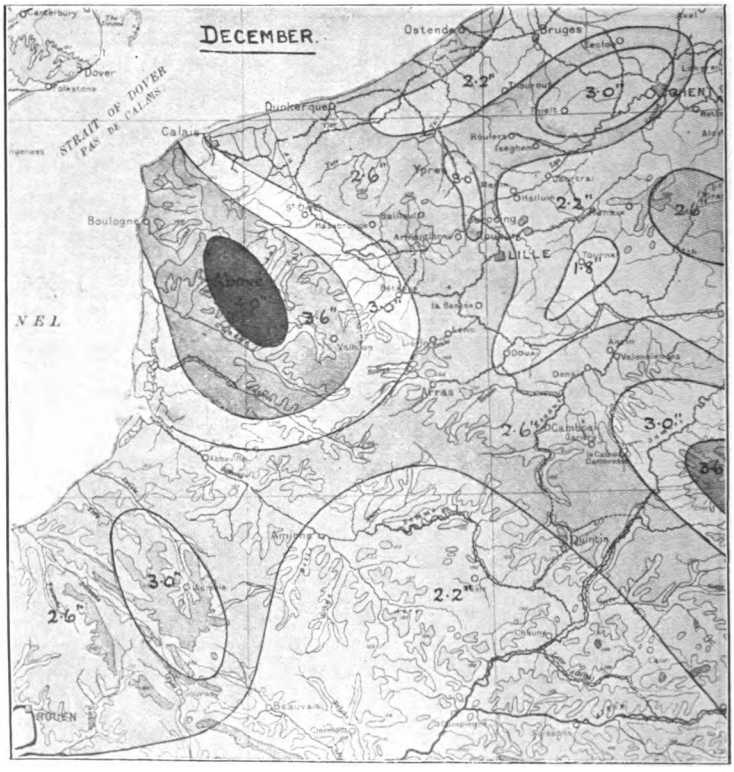

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upon radiators and machinery for the guidance of Transport and other officers: for information about gales in connection with claims for damages.

Among other miscellaneous purposes for which meteorological information was supplied may be mentioned:—

(*a*). Warnings of frost or snow for the information of Transport Services.

(*b*). Warnings of thaw, for the guidance of those responsible for the issue of regulations about traffic, known as "thaw precautions."

(*c*). Information about upper wind in connection with the dispatch of pigeons and literature by balloons drifting over the enemy lines; on two or three occasions also similar information was supplied for use with man-carrying balloons.

(*d*). Forecasts of weather and visibility as regards fitness for photographic work.

(*e*). Information as to the probable weather conditions present and future over Belgium, Heligoland, Lower Rhine and Upper Rhine, for the guidance of the Intelligence Branch of the Staff.

(Previous articles under the heading of "The Work of the Royal Engineers during the European War, 1914—19" appeared in the *R.E. Journals* of September, 1919 (Introduction p. 105; Anti-Aircraft Searchlights, France, p. 106; Postal Section—Army Postal Services, p. 114), October (Bridging, Chapter I., p. 162), November (Bridging, Chapter II., p. 200), December (Bridging, Chapter III., p. 261), January 1920 (Bridging, Chapter III., (*concluded*), p. 13), February (Bridging, Chapter IV., p. 61; Organization of Engineer Intelligence and Information, p. 79), March (Bridging, Chapter V., p. 149), April (Bridging, Appendix—Formation of R.E. Bridging School. p. 189), May (Work in the Field under Various Branches of the Staff—Forestry, p. 247). Copies of these Journals may be obtained through the usual channels.)

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DESCRIPTIVE RECORD OF WORK DONE BY 85th FIELD COMPANY, R.E. DURING RECONNAISSANCE IN FORCE ACROSS THE STRUMA IN SEPTEMBER, 1916.

DURING the month of September 1916 several reconnaissances in force were made across the Struma and in almost every case boat-rafts made and worked by R.E's were used.

The first reconnaissance in which the 85th Company took part was on the 15th of the month.

The 31st Brigade were to cross at Zouave Ford and 29th Brigade at Chasseur Island, and a small flank force at Gudeli Ferry.

At Zouave Ford four boat-rafts were constructed about a mile back from the river so that the sound of hammering would not carry to the Bulgar lines. These boat-rafts were simply wooden frame-works, 16 feet by 12 feet and 3 feet deep, which were covered by 30 feet by 30 feet tarpaulins, the flooring being made of corrugated iron. During the night they were carried down to the river, and in the early morning two men swam across with a cable and put in an anchorage about 50 yards up-stream. The four rafts were fastened in a tail and the whole party, about 600 strong, was got across in two trips without a hitch.

At Chasseur Island one boat-raft had been constructed and was similarly worked by an upstream rope. This raft carried over roughly 400 men in an hour.

At Gudeli Ferry a small raft, about six feet square, was constructed, which also operated successfully.

The Bulgar artillery searched for these crossing places but never got within 200 yards of the crossing until about an hour after all the troops were safely back, when a barrage was put down on Zouave Ford.

On the 23rd, a reconnaissance was made on the right by the 180th Mounted Brigade in co-operation with the French. The main crossing was made at Suha-banga, the French crossing being made at Fitoki.

Two sections of 85th Field Company were lent to construct and work raft-boats in conjunction with the 1/2nd Wessex Company. Four boat-rafts 16′ by 12′ were constructed on the 22nd at Suha-banga, about two miles from the river, and carried down on wagons during the night.

During the early morning four parallel cables were run out across the stream, about ten yards apart, and one boat was connected to each cable by a ring, two tow ropes being used to pull the rafts to either shore, and by midday everything was ready, landing stages

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having been made at each bank for all the boats. Two of the boats were handed over to 1/2nd Wessex Company to operate and the other two were worked by 85th Field Company. By 1.30 p.m all the troops were across, each boat having carried over about 200 men. The position of the crossing place was not located by the Bulgar artillery and not a single shell landed in the vicinity.

About 3 p.m. the river started to rise rapidly, and by 6 o'clock it had risen about three feet, making the landing places inaccessible. This was overcome by cutting large quantities of brush-wood and constructing a floating platform. All the cables held in spite of the very considerable extra strain put on them, caused by the increase in speed of the current, and all troops had been safely brought back by 9 p.m., by which time the river had risen nearly five feet.

During the night of the 24th word was received that the rafts of the French had been swept away, leaving a hundred men on the far side of the river, and, that two men had been drowned in trying to swim across, having got caught up in the barbed wire, which had been put in the bed of the river at the ford some time before when the river was low. As they had no engineers they called upon the 85th Field Company, who were nearest to them, to help. A small detachment was sent down with materials for a boat-raft and at the same time a message was sent informing them that the rafts at Suhabanja would be put in operation if they could work up to that point.

On arrival at Fitoki it was found that a large backwater about half-a-mile wide had been formed by the rise in the river, and this had to be crossed to get to the bund on the bank which was still above water. A cable was run out across the backwater, and communication established with the bund by means of a small boat.

A small raft-boat, six feet square and three feet deep, was constructed, covered by a tarpaulin, and this was towed out to the bund. The distance to cross to the other bank was about 80 yards and the current was running about nine knots. Fortunately a telephone wire left by a F.O.O. on the previous day was found about three hundred yards upstream and by means of this a cable was got across. As there was only one other long cable left the boat had to be pulled across by the crew on this cable. As the space in the boat-raft was very limited only four could haul on the rope, and it took two hours to get the boat to the other side, the second cable being paid out behind. Once across the matter was more or less simple, the boat being connected to the main cable by a snatch block and the second cable tied at its centre to the boat was long enough to allow for a hauling party on both banks. The French were brought back twelve at a time and the cable at the far bank was released and tied to the boat on the final trip, which was safely accomplished, the last load arriving at the bund just before dark.

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BOOKS ON ENGINEERING, TELEGRAPHY AND TELEPHONY, AND RAILWAYS,

ENGINEERING.

The following may be added to the list of Books on Engineering recommended to officers in the *R.E. Journal*, November, 1919 :—

STRUCTURAL ENGINEERING.—By J. Husband, Assoc. M. & Watts' Medallist Inst. C.E., etc., etc., Head of the Civil Engineering Department of the University of Sheffield, and W. Harby, sometime Assistant in the Civil Engineering Dept. of the University of Sheffield. Published by Longmans, Green & Co.

This is one of the best books of its kind that we have seen. Without being too bulky or detailed, it contains in readily accessible form, a great deal of valuable information. The methods of design are modern and are treated in a very thorough and practical way, and are easy to follow.

Chapter I. deals with Materials. Chapter II. with Loads and Working Stresses, and includes Tables of Traffic Loads on Highway Bridges, and equivalent Distributed Loads on Railway Bridges for varying spans ; Table of Stones' " Range " Formulæ. etc. Chapter III., Bending Moments and Shearing Force. Chapter IV., Beams. Chapter V., Columns and Struts. Chapter VI. gives the design in detail of a Plate Girder. Chapter VII., Lattice Girders. Chapter VIII., Deflection, including the deflection and horizontal deflection of braced girders by the method of " Work." Chapter IX., Roofs. Chapter X., Miscellaneous and Tall Buildings. Chapter XI., Masonry and Masonry Structures, Foundations, Gravity Dams, Arches (rigid and hinged), and Tall Chimneys.

MATERIALS.

JOHNSON'S MATERIALS OF CONSTRUCTION.—Rewritten and edited by F. E. Turneaure. 1919. 5th Edition. Published by John Wiley & Sons, New York (Chapman & Hall, London).

The authors aim to provide essential information concerning the sources and manufacture of the principal Materials of Construction ; to give carefully selected data covering the more important mechanical and physical Properties and the influences of various factors upon these properties ; to show the causes of defects and variations and how they may be discovered ; to furnish an acquaintance with the technique of testing materials ; and to present some of the more general uses of the materials.

Chapter I. gives a synopsis of the Principles of Mechanics of Materials. Chapters II. and III. deal with Machines and Appliances for Testing, the Technique of Testing and the Utility of the various Tests. Chapters IV.—VI. consider the Characteristics, Methods of Identification, Properties and Uses of the more Important Woods, also Causes of Decay and Means of Preservation. Chapter VII. treats of the Important Stones, their Constitution, Durability, and Properties. Chapter VIII. covers the Manufacture and Testing of Structural Clay Products, together with their Mechanical Properties and Uses. Chapters IX.—XII. deal with the Nature, Manufacture, Methods of Testing and Properties of Hydraulic Cements, Limes and Plasters. Chapters XIII.—XV. fully describe Methods of Making Mortar, Concrete, and Concrete Products, also the Properties and Uses of these Materials. Chapter XVI. provides a brief summary of the Utility of the Principal Metals, their Ores, and Fundamental Considerations governing their Extraction. Chapters XVII. to XIX. treat of the Reduction of Iron from its Ores and subsequent Purification and Fabrication. Chapters XX. and XXI. deal with the Formation and Structure of Alloys in general, and the Constitution of Iron and Steel. Chapters XXII.—XXIV. are devoted to a discussion of the Properties and Uses of Wrought Iron, Steel, and Alloy Steels. Chapter XXV. takes up the Manufacture, Moulding, Constitution, and Properties of Cast Iron and Malleable Cast Iron. Chapter XXVI. treats of the Production, Properties and Uses of Copper, Zinc, Aluminium, Lead, Tin, Nickel and their alloys. Chapters XXVII. to XXIX. cover the effects of Temperature on Metals, the Causes and Effects of Fatigue, and the Corrosion and Protection of Metals.

The book is thoroughly up to date and contains much valuable information on the latest processes, tests, and specifications applied in the U.S.A., and is strongly recommended *for study* and practical reference.

FOUNDATIONS.

FOUNDATIONS OF BRIDGES AND BUILDINGS.—By H. S. Jacoby and R. P. Davis. 1914. Published by McGraw-Hill Book Co., New York (Hill Publishing Co., Ltd., London).

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Chapters I.—III. deal very fully with Timber Piles, Pile Driving and Bearing Power. Chapter IV. describes various types of Concrete Piles, their Relative Advantages, Cost, Bearing Powers, and Method of Driving. Chapter V., Metal and Sheet Piles. Chapter VI., Cofferdams. Chapter VII., Box and Open Caissons. Chapters VIII—X., Pneumatic Caissons for Bridges. Chapter XI., Pier Foundations in Open Wells. Chapter XII., Ordinary Bridge Piers. Chapter XIII., Cylinder and Pivot Piers. Chapter XIV., Bridge Abutments. Chapter XV., Spread Foundations. Chapter XVI., Underpinning Buildings. Chapter XVII., Investigation of Subsoil and Loading Tests. Chapter XVIII., Pneumatic Caisson Practice. Chapter XIX. References to Engineering Literature.

The theory given in this book is everywhere very fully supported, or its limitations shown, by records of experience and observations of engineers and contractors representing the best American practice. The subject of timber piles is especially fully treated on the grounds of their extensive use in the U.S.A. for rapid and economical construction chiefly in connection with railway and marine work. The great change in the design of foundations, piers and abutments, effected by the application of reinforced concrete is well brought out and emphasized. Specifications, labour and cost analyses, in each branch of the subject, add largely to the value of the book. The book is strongly recommended to any officers who may have heavy or difficult foundations to deal with.

FOUNDATIONS AND MACHINERY FIXING.—By F. H. Davies, A.M.I.E.E. Constable & Co. Price 2/-.

Deals with the Design and Construction of Foundations for Machinery of various types.

Chapters I. and II., Foundations Generally. Chapter III., Design. The Proportion of Foundations for Engines, Turbines, and Dynamos. Chapter IV., Materials for Foundations. Chapter V., Holding-down Bolts and Anchor Plates. Chapter VI. and VII., Practical Construction. Chapter VIII., Vibration, its causes and effects. Chapter IX., Methods of Isolating Machinery, to prevent the Vibration affecting the neighbourhood. Chapter X., Fixing of Electric Motors.

ROADS.

HANDBOOK FOR HIGHWAY ENGINEERS.—By W. G. Harger, C.E. and E. A. Bonney, Supervising Engineer, N.Y. State Dept. of Highways. Published by McGraw-Hill Book Co., New York (Hill Publishing Co., London). 1919.

Part I.—Principles of Design:—Grades and Alignment; Sections; Drainage; Earth, Sand-Clay, and Gravel Roads; Gravel and Stone Foundation Courses; Macadam Top Courses and Rigid Pavements; Maintenance; Minor Points; Materials.

Part II.—Practice of Design and Construction:—Preliminary Investigations; Survey; Photography, Notes on Camp Equipment, etc.; Office Practice; Cost Data and Estimates; Notes on Inspection.

Part III.—Specifications:—General Outline; Examples of Current Practice; Materials; Construction Methods; Road-bridge Specificatinns.

Part IV.—General Tables and Formulæ.

The purpose of the book is to collect in a compact and convenient form (pocket size), information ordinarily required in the field and office practice of road design and construction. The book is designed to meet the requirements of both experienced and inexperienced road engineers. The possibilities of economy without impairing the efficiency of the road are emphasized.

The authors are not advocates of rigid concrete surfaces, and consequently the subject is only briefly dealt with, the latest practice in concrete road-making being omitted. With this limitation (omission to deal fully with concrete roads), the book is recommended as providing much useful information.

TELEGRAPHY AND TELEPHONY.

The best books at the moment on Telegraphy, Telephony and construction, etc. are published by the Post Office. The following have recently been presented to the Corps Library by the Engineer-in-Chief, G.P.O.:—

CONSTRUCTION OF AERIAL LINES ON ROADS AND RAILWAYS. 1911.

TESTING AND JOINTING OF CABLES REQUIRED FOR SUPERPOSED TELEGRAPHIC WORKING. 1919.

CONSTRUCTION OF UNDERGROUND TELEGRAPH AND TELEPHONE LINES. 1919.

WIRING OF BUILDINGS. 1912.

Other good books are:—

Herbert's TELEGRAPHY (revised edition).

J. G. Hills' TELEPHONE TRANSMISSION.

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WIRELESS TELEGRAPHY.

The following books on Wireless Telegraphy and Telephony are recommended :—

HANDBOOK OF WIRELESS TELEGRAPHY AND TELEPHONY.—By Dr. W. Eccles.

TEXT BOOK OF WIRELESS TELEGRAPHY. Vol. I., General Theory and Practice. Vol. II., Valves and Valve Apparatus.—By Rupert Stanley, B.A., M.I.E.E. (Longmans, Green & Co.).

TELEPHONY WITHOUT WIRES.—By P. R. Coursey, B.Sc. (The Wireless Press).

THE ELEMENTARY PRINCIPLES OF WIRELESS TELEGRAPHY.—By R. D. Bangay (The Wireless Press).

THE WIRELESS TELEGRAPHISTS' POCKET BOOK.—By J. A. Fleming, M.A., D.Sc. (The Wireless Press).

THE PRINCIPLES OF ELECTRIC WAVE TELEGRAPHY AND TELEPHONY.—By J. A. Fleming, M.A., D.Sc. (The Wireless Press).

RAILWAYS.

The following is a list of books on Railway Engineering, Operating, Goods Working, Locomotives, and Railway Signalling. The list is obviously by no means exhaustive, and there has only been included such a selection as is most likely to be of use to R.E. Officers. It should be noted that no books on Machine Tools, or Machine Shop Practice (in connection with locomotive construction and maintenance) have been included, as these apply generally to all forms of mechanical engineering :—

TEXT BOOKS ON RAILWAYS.

PERMANENT WAY MATERIAL.—By W. H. Cole. Spon, 1915. 7/6.

RAILWAY CONSTRUCTION.—By W. H. Mills. Longmans, 1898. 18/-.

RAILROAD STRUCTURES AND ESTIMATES.—By J. W. Orrock. Wiley (N.Y.), 1909. $3.00.

RAILROAD TRACK AND TRACK WORK.—By E. E. R. Tratman. "Engineering News" (N.Y.), 1908. 14/-.

RAILROAD CONSTRUCTION.—By W. L. Webb. Wiley (N.Y.), 1908. 21/-.

ECONOMIC THEORY OF THE LOCATION OF RAILWAYS.—By A. M. Wellington. Wiley (N.Y.), 1903. 21/-.

FIELD ENGINEERING.—By Searles & Ives. Chapman & Hall (Wiley), 1881. 14/6.

TRACK FORMULÆ AND TABLES.—By Roberts. Chapman & Hall (Wiley). 13/6.

ECONOMIES OF RAILWAY OPERATION.—By M. L. Byers. "Engineering News" (N.Y.), 1908. 21/-.

WORKING AND MANAGEMENT OF AN ENGLISH RAILWAY.—By Sir G. Findlay. Whittaker, 1894. 7/6.

EFFICIENT RAILWAY OPERATION.—By H. S. Haines. Macmillan Co. (N.Y.), 1919. $4.00.

RAILROAD TRAFFIC AND RATES (2 Vols.).—By E. R. Johnson and G. G. Huebner. Appleton (N.Y.), 1911. 21/-.

RAILROAD ADMINISTRATION..—By R. Morris. Appleton (N.Y.), 1910 7/6.

PRACTICAL RAILWAY WORKING.—By C. Travis, D. R. Lamb, and J. A. Jenkinson. Boswell, 1915. 3/6.

FREIGHT TERMINALS AND TRAINS.—By J. A. Droege. McGraw-Hill (N.Y.), 1912. 21/-.

RAILWAY GOODS STATION.—By F. W. West. Spon, 1912. 4/6.

RALWAY STORES MANAGEMENT.—By W. O. Kempthorne. Spon, 1907. 10/6.

LOCOMOTIVE OF TO-DAY.—Locomotive Publishing Co. 3, Amen Corner Paternoster Row, E.C.4. About 3/6.

LOCOMOTIVE PERFORMANCE.—By W. M. Goss. Wiley (N.Y.), 1907. 21/-.

THE RAILWAY LOCOMOTIVE.—By V. Pendred. Constable, 1908. 6/-.

MANUAL OF LOCOMOTIVE ENGINEERING.—By W. F. Pettigrew. Griffin, 1909. 21/-.

MODERN LOCOMOTIVE PRACTICE.—By C. E. Wolff. Sc. Publ. Co., 1903.

LOCOMOTIVE OPERATION AND TRAIN CONTROL.—By A. J. Wood. McGraw-Hill (N.Y.), 1915. 12/6.

FIRST PRINCIPLES OF RAILWAY SIGNALLING.—By Byles. Railway Gazette, Queen Anne's Chambers, S.W.1.

MECHANICAL RAILWAY SIGNALLING.—By Reynar Wilson.

POWER RAILWAY SIGNALLING.—By Reynar Wilson.

RAILWAY SIGNAL ENGINEERING.—By Lewis. Constable, 1912.

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CORRESPONDENCE.

ORGANIZATION AND EMPLOYMENT OF ENGINEERS IN WAR.

To the Editor of the R.E. JOURNAL.

In the issue of the *R.E. Journal* for May a footnote asks for views on the subject of the lecture delivered at the S.M.E. in March last by Major General H. F. Thuillier, C.B., C.M.G. This is my excuse for the following remarks.

If the strength of the R.E. in a Division is taken at 1,600 to 2,000, as suggested by the lecturer, the unsolved problem is, how to best combine these troops into suitable units for all purposes, based on the section formation. The solution would appear to lie in a consideration of what work is likely to be done, and what size of unit forms the maximum and minimum for administrative convenience and economy.

It may be taken for granted that the command of a R.E. Major would be from 200 to 600 men. The minimum size of a unit is governed largely by economy in administration, and in addition by the disadvantage of increasing in number the already numerous small special R.E. units. The obvious solution of three double-companies of approximately 600 each of all ranks, would leave out that small but essential unit, which is called by the lecturer the headquarter company. Also it must be remembered that future wars will probably not be on the same lines as the late war. Consequently the possibility of having to detach a R.E. unit from the Divisional area, for a long or short period, must not be overlooked. With three double-companies, such a detachment would either be a whole double company, which would seriously deplete the strength of the Divisional R.E., or a portion, say half a double-company. This can hardly be an entirely self-contained unit. However closely the organization of a double-company is made to allow of each half being self-contained, it must be impossible to make it entirely so without, in normal times, an extravagant employment of administrative *personnel.*

The larger form of unit, exemplified by the double-company, has obvious advantages when the nature of employment of the R.E. is considered. For example the laying of pipe lines, the construction of trenches, road construction and repairs and the numerous small tasks, all interdependent and collected in a circumscribed area. These require one directing head and many willing hands, to carry them out. On the other hand, bridging, concrete work, workshops, construction of artillery O.P's, and battery positions, camouflage, etc., will frequently require small and scattered parties, which could best be provided from a unit of about 200 strong, a unit in which the O.C. can find time to visit every party daily, however widely they are scattered within the Divisional area.

With the above in view, would not the case be met by arranging

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the strength of the Divisional R.E. in two double-companies and two single companies? The double-company could be organized on almost the same lines as two single companies, with the obvious administrative modifications which the advantages of the double-company system imply. This would give four R.E. units, a feature of which is worthy of notice, namely that the number is not the same as the number of Brigades, but is a multiple of the number of units normally operating on a Divisional front. This might overcome the tendency in Brigades of looking on a certain field company as their own property, and would seem to give the C.R.E. a very flexible command. As an example of a possible form of employment of these four units, either in open or trench warfare, one might consider the two double companies as permanently employed in the forward area, carrying out their own reliefs between half companies. The O.C. alone would be permanently in touch with the front line, a condition of affairs which would hardly be looked on by the O.C. himself as a disadvantage, and which, from the point of view of efficiency and continuity of policy has many features in its favour.

One of the single companies could then carry out the duties of the headquarters company with a proportion of its strength. The remainder say one half, could meet the probable requirements of the artillery. The second single company, which would relieve the first company mentioned above from time to time, would be available for the multifarious duties necessitated by the nature of R.E. work and the many special requirements emanating from the Divisional Commander and his staff. It would also meet probable requirements for a R.E. detachment outside the Divisional area. An obvious case of the utility of such a unit is in a retreat. It would be at hand for demolitions, a work which was not always thoroughly carried out, owing to the R.E. units being otherwise employed. The only other feature involved in the above proposal is that of the more highly skilled tradesmen and the more highly technical tools, which it is suggested should be provided for the headquarter company. The more highly skilled men could well be duplicated in the two single field companies without any disadvantage, and so be available to double man a task in an emergency. The men would run scarcely more risk of being wounded or killed, than if they were employed further behind the line in units which would certainly be well bombed. The more highly technical tools could also be duplicated in the same way in view of the conditions obtaining in modern warfare, and the fact that tools are not infallible, they sometimes break or get out of order and require immediate replacement. Naturally there would be some few machines which would not be supplied to a greater extent than the essential minimum, but presumably a C.R.E. is not going to be entirely denuded of transport in the future, as he was in the past, and these machines could be on charge to headquarters and travel in the H.Q. transport.

The lecturer's remarks on allocation of responsibility would appear to meet the views of all field company commanders. But one reason for the past faults and mistakes should not be overlooked. This reason was that both senior officers of the R.E. and commanders of formations

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did, in fact, blame the executive R.E. officer for anything that went wrong in those features which might conceivably be included under the heading of engineering. The R.E. officer was the easiest to get at, and it was not difficult to find his name. The responsible officer of another arm was often difficult to locate, as, after completing his task he was absorbed back into his unit for ordinary duties and left no trace of his indentity. In consequence the R.E. officer got accustomed to expect blame for any slackness or mistakes occurring in the area in which he was working, and consequently took charge, for his own sake, when it was unnecessary and incorrect for him to do so. The solution of the difficulty by the inclusion in the orders of the staff the name of the commander or formation responsible for any particular work, would appear to radically alter this state of affairs for the better.

The only other point which I would wish to emphasize, may perhaps not be considered as covered by the field of the lecture, but is closely connected with its subject. This is the question of equipping the Divisional R.E. with machinery, such as a lathe, portable saw mill, mechanical pumps, acetylene metal cutting and welding plant, and also water supply tools and fittings. This equipment need be no more liable to destruction with a Division than in a Base Park where it would be certainly bombed. Nor would the few skilled men required to work them, seriously deplete the working strength of the Divisional R.E. The correspondence and rail transport saved, the convenience and more rapid execution of work, and the more complicated technical problems to be met with on the modern battlefield, would more than justify this innovation.

Yours faithfully,
A. T. SHAKESPEAR, *Capt., R.E.*

To the Editor R.E. JOURNAL.

SIR,

As you and Major General Thuillier invite discussion of the lecture delivered by the General and published in the *R.E. Journal* for May 1920 I venture to contribute some remarks to the discussion.

Five Main Factors.—The lecturer began by stating that he could deal with only a portion of such a big subject and I must do the same, referring however to some matters not touched on in the lecture.

An Engineer in War, as in Peace, must keep constantly in mind five main factors when preparing for or executing work.

(1) Time.
(2) Skilled Labour.
(3) Unskilled Labour.
(4) Material and Plant.
(5) Transport for Material and Working Parties.

I have not attempted to place them in order of importance because all are equally important and the absence of any one will wreck the whole. The proportion of each varies with every work and a skilful balancing of proportions ensures rapid, efficient and successful work.

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In my remarks I propose to keep constantly in mind all the five factors and I would ask the reader to do the same.

In peace time an Engineer does not attempt to begin work until he has arranged for all the five factors to be duly proportioned, but I have yet to meet the happy Engineer who was able in war to secure all five to his satisfaction. Perhaps the skilled labour has been with difficulty collected and at a moment's notice is sterilised by the unskilled labour being swept off by a higher power, or the material was not available, or the transport was switched off to ammunition and supplies, leaving his labour idle. These are difficulties with which the Engineer in war of any rank from N.C.O. to General has to contend and surmount and by the side of which the most abstruse Engineer problem seems comparatively simple.

Doctrine.—A great deal can be done by organisation in peace and as General Thuillier says by the establishment of a universally accepted "Doctrine" to make things easier in this respect in the next war for our successors, or possibly for ourselves!

For instance, take "War Establishments." If an individual, a vehicle, an animal, an article of store, or a unit is in "War Establishments" it is comparatively easy to get it. It may be forced upon you whether you want it or not, but if it is not in "War Establishments," one or two disasters must occur before it is put there. Hence the importance of getting "War Establishments" thoroughly complete and right. Never mind if there is no immediate chance of getting the men or the articles. Get them into the book and some day they will be thrown at us.

Skilled and Unskilled Labour.—General Thuillier has emphasised the necessity for the C.R.E. (whether of a Divn. or on Communications) commanding and administering the unskilled as well as the skilled labour to be employed on work for which he is responsible, and we may hope this is now established "Doctrine," but I venture to ask why put them in the same unit? In asking this I see that I am questioning what the General says is the second point on which there is universal agreement, and I must give reasons for my heresy.

The proportion of skilled to unskilled labour varies with the job. For trench work, for roadmaking, for what I may call heavy labour jobs it will vary from 1 to 5 up to 1 to 10. For bridging, for building and for skilled jobs it will vary between 1 to 2 and 1 to 4.

If you have your skilled labour in companies and your unskilled also in companies but the latter grouped into battalions all under the C.R.E., the proportion of skilled to unskilled labour is easily altered without dislocation of units. One or more sections or companies or battalions of unskilled labour are detailed to work with one or more sections or companies of Engineers.

On a bridging job a Company of Engineers may perhaps have two companies of labour while on the bridgehead defences another Engineer company has two labour battns.

Compare this elasticity with laying down for all time in immutable "War Establishments" that the skilled *personnel* will be "25% to 30% of the whole."

No man should be called or dressed as an Engineer unless he is a

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"skilled tradesman." I maintain that this principle is a veritable sheet anchor in the Corps organisation to which we should hold regardless of the temporary difficulties which prevent us getting tradesmen. We are organised for war, and temporary peace difficulties are beside the question, apart from the possibility of overcoming them. When we see a man in the field dressed as an Engineer let us know at a glance that in him we have a skilled tradesman and not discover by his work that he is a labourer dressed as an Engineer.

Again if we adhere to this principle we are protected during the rush of hasty organisation in war from being swamped with unskilled men. Will even the 25% to 30% of skilled men be worked up to when any man can be enlisted as an Engineer? We all know how drafts and reinforcements are sometimes collected and rushed up. When all are dressed alike who is going to prevent a unit being swamped with unskilled men?

Yet another point. We fight in many countries where the local inhabitants can be organised in companies and battalions of unskilled labour and where on account of climate he can carry out labour jobs better than the English labourer. Some units of British labour must always be available for the front line work on which the inhabitant of the country can be employed to a limited extent only, but the units of skilled men must still bear the same proportion to unskilled. On the Western Front during the war the proportion of unskilled British labour in the forward zone was necessarily much higher than was practicable or desirable in Macedonia, Palestine, and countries where the native labour was suitable, but skilled British labour was as necessary in every theatre of war. Again compare this elasticity in organising skilled and unskilled in separate units with combining them in one immutable War Establishment.

We must recognise that we shall never be allowed the monopoly of unskilled labour. Wars are unfortunately not got up in order to enable C.R.E's to carry out perfect Engineering work. Other inconvenient people come butting into the War. All we can hope for is to get a certain number of units definitely enlisted as Engineer labour units, commanded and administered by C.R.E's and always working with Engineer units. For every company of Engineers we may hope to have an Engineer labour battalion, but as already shown this proportion of unskilled to skilled labour will not always suffice. The remainder must come from the Army "Pool" of labour battalions and infantry working parties from which all the other inconvenient people also draw their labour and join with us in the scramble to get it. If only we can get it laid down as part of the "Doctrine" that for every R.E. Coy. about 250 strong, we are to enlist command and administer and permanently retain one Engineer labour battalion 1000 strong then this combination would have no difficulty in absorbing on occasions and efficiently directing much larger quantities of unskilled labour temporarily allotted from the "Pool."

Space forbids me giving reasons for the opinion that every R.E. unit should be a company not less than about 250 strong, with 6 officers, and that units much smaller than this whatever the nature of their work or speciality tend to be inefficient and uneconomical.

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A great advantage that would follow from organising Engineer labour battalions in peace and in war commanded by Majors (who on the work would rank junior to Majors of R.E. Companies), is that we at once open up a fine career for our N.C.O's and sappers who could exclusively provide the officers for these Units.

Transport.—Next as to Transport. The same principle applies. We want it established in the " Doctrine " that with every R.E. Company and with every Engineer labour battn. there is an irreducible minimum of transport (quite apart from what is required for moving their equipment and food) which is definitely allotted for works transport to carry material and stores to the working parties and into the work *and to move working parties* from place to place. This latter point is often overlooked, but in moving warfare either in advance or retreat is especially essential. The Engineers with advance guard settle down to a job and before it is finished are passed by the rear guard. Another party leap-frogs over them carried forward in lorries. The original party finishes its job, thanks to the transport which brings it material, then gets into the transport and catches up the advance guard. To this irreducible minimum, without which each unit is helpless for work, a further quantity of transport, varying with the nature of the job and with the C.E's or C.R.E's capacity for scrambling, is added from the Army " Pool."

In this connection I remember the " hue and cry " after six lorries which had completely disappeared. When a certain C.R.E. had arrived at the Danube it was considered politic to ask if the lorries he possessed could by any chance be the missing ones.

Incidentally I submit that Engineer units allotted to cavalry should have four-fifths of their *personnel* in Ford cars and one fifth on horses.

Stores and Material.—Our organisation for stores in war and in peace also requires thorough overhaul. As War Establishments ignored the subject, every C.R.E., every C.E., every A.D.W. improvised Stores Establishments by taking away valuable tradesmen from R.E. Companies that could ill afford to lose them. The establishment and the unskilled labour they require for loading and off-loading must make its appearance in War Establishments, likewise the Establishment of clerks and draughtsmen of C.E's and C.R.E's requires overhaul.

Doctrine Again.—I make no apology for returning to the subject of " Doctrine " because General Thuillier has emphasised the importance of our knowing our own minds, firstly as to how we wish to be organised and secondly how we can best assist the army to accomplish its work, and then coming to an understanding with the Staff upon this " Doctrine."

There seems now to be considerable unanimity on these matters in the Corps. I have not met any R.E. who would not welcome the clear exposition given by the lecturer of the " Functions of C.R.E." " Employment in the Field " " Allocation of Responsibility " " Duties of C.R.E." &c., &c., to the end of the lecture. Many difficulties will be cleared away, on the day when the rule is laid down, and observed by all, that all works are divided into two categories.

(1) Those for which the R.E. are responsible.

(2) Those for which the Infantry and other arms are responsible.

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Before the war we really did not know ourselves what our "Doctrine" should be. Now we do, and are ready to discuss it with the Staff and get them to lay down a "Doctrine" which all will adhere to. That at present remains to be done. We must cease to be a mystery box that no fellow can understand. The principles of the employment of R.E. in different phases and operations of war should be as widely known and adhered to as the employment of other arms.

I attended a Staff Ride two months ago at which all were veterans of the war whose knowledge of every principle and detail gave me a valuable education, and yet in the attack of a position several of them allotted each section of a Field Company to each battalion to accompany it in the assault without a defined mission, and I know my remonstrance was not popular.

In this connection I would urge that it is most necessary that officers of other arms, and particularly Staff College students should be attached to us during the training season and also to our works offices. Why are we left out when they go for attachment to other Arms? Brigade Majors and Staff Captains work in the very closest *liaison* with field company commanders, G.S.O. (I.) and A.Q.M.G. with C.R.E., B.G.G.S., and D.A. and Q.M.G. with C.E., &c. I doubt if any other arm is in closer connection with the Staff. Why then are the Staff students not attached to us to learn our methods and our difficulties, and particularly to realise how we must balance the proportions of the five main factors referred to at the beginning of this effusion? I do not think anyone who has not been responsible for works can realise the quantity of material required for quite small works and the transport to bring it there. The timber used in quite a small bridge when stacked in a heap looks incredible. If the Staff will lay down a doctrine, preferably that expounded by General Thuillier, and insist on Commanders adhering to it during all training, and if we are attached to other arms and they to us, the doctrine will eventually be established and universally accepted so that we all work on the same lines for the same object.

I am, &c., &c.,

H. L. PRITCHARD, *Brevet Colonel, R.E.*

REVIEWS.

ELEMENTARY AERONAUTICS

By A. P. THURSTON, D.Sc., late Captain, R.A.F. (Sir I. Pitman, Ltd.). Price 7/6 net.

This is the second edition of this little work, the first having been published a few years ago. It is a useful book and particularly suited to those who wish to get a good general idea of the subject. In the

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first two chapters, the general theory of plane and curved surfaces is discussed and the usual formulæ for air pressure, centre of pressure, etc., are given in some detail. Stream lines, and the formation of surfaces of discontinuity are clearly explained and the resistances of bodies of different kinds are also given. In the next two chapters the principles of "stability" and "control" are described, in a clear and simple manner—In a future edition it would be advantageous to discuss "Yawing" in detail.

In *Chapters V. and VI.* the general theory of air screws is explained and there are some notes on the "Helicopter." The curious application of this latter apparatus to an aeroplane, suggested by Bleriot is commented on.

Chapter VII. is of interest, as it describes one of the earliest attempts to calculate the forces, etc., acting on an aeroplane in flight. The necessary details are well shown in the diagrams. An account of laboratory instruments follows, and a brief description of some of the earlier aeroplanes is given.

Chapter X. describes some of the aeronautical engines in common use. The illustrations are good.

Chapter XI. on the methods of stressing aircraft structures, is important, as it explains the system used by the author in his official work. The final remarks on design will be found useful by constructors.

In *Chapter XII.* "Air Friction" is fully gone into. The author says truly that "more controversy has raged round this question than around any subject in aeronautics"—The reason for this is, that in the experimental work, it seems to be impossible to separate "form resistance" from "frictional" resistance and it is extremely doubtful whether any of the experiments described really do this. The author's idea of using glass plates, so as to ensure a smooth surface was a very good one, but probably better results would have been obtained, if they had been "fair shaped" in section. The whole subject is a very difficult one and a great many points have to be considered in connection with it; for instance, the probability of a particular air velocity giving the minimum resistance, and so on.

There is an interesting chapter on "Pressure Distribution," and the tables regarding strength of timber, etc., will be found useful by constructors.

J. D. FULLERTON, *Colonel, R.E. (ret.)*.

PAGES D'HISTOIRE, 1914—1918.

(Librarie Militaire Berger-Levrault, 5—7 Rue des Beaux Arts, Paris).

(*Continued from R.E. Journal for May*, 1920).

The 165th number of this series is entitled *Le Bolchevisme en Russie*; the volume is a translation into French of the White Paper presented to the British Parliament in April, 1919, on the situation in Russia.

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and covers the period August, 1918 to March, 1919. In addition to the correspondence between the Foreign Office and various diplomatic, and consular officials and military officers, the volume contains a number of important memoranda dealing with different aspects of the situation arising from the state of anarchy prevailing in the erstwhile Russian Empire. In an Appendix to this volume will be found extracts (in French) from the Russian Press covering the period September, 1918, to February, 1919. They disclose the unhappy state of the country and what the people are suffering from the reign of terror that prevails therein.

The 166th number is entitled *Paris pendant la Guerre* and is from the pen of M. Gaston Cerfberr. The vicissitudes through which the inhabitants of the French capital passed from the time of the declaration of war in the autumn of 1914 to the joyous days in the summer of 1919, when fêtes were organised to celebrate a glorious peace, are briefly described. Owing to its geographical position in relation to the contending forces, the Parisians were made to feel the full effect of what a modern war means; they accepted their trials in a spirit of fortitude and made the best of an anxious and uncomfortable situation. M. Cerfberr touches upon practically every aspect of life in Paris during the great struggle; *e.g.*, the mobilization of the troops; the requisitioning of horses, etc.; the approach of von Kluck's Army to the defences of the French capital; the Zeppelin raids; the bombardment by "Big Bertha"; the exodus of 1918; the introduction of rationing; taxation; the difficulties of obtaining supplies; the economic situation, etc. References are also made to the visits of the British Sovereign, of the King of Belgium, of the Italian King, and of President Wilson.

The 167th number contains the official communiques issued by the Central Government to the Provincial Authorities during the period October—December, 1918; it is the XXXIX. volume of the series dealing with such matters.

W. A. J. O'MEARA.

THE BATTLE OF THE MARNE.

By G. H. PERRIS (Methuen). 10/6.

The author, who was war correspondent with the French armies, gives a clear and detailed account of the various phases of the great battle, well supported by plans and numerous references. But the account is almost entirely from French sources, and the student, who begins to know something of what occurred on the other side, will look in vain for a description of the mistakes made and difficulties encountered by the Germans, which had such a far-reaching influence on the results of the battle. The book has been placed in the Corps Library.

F.E.G.S.

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THE THEORY AND PRACTICE OF AEROPLANE DESIGN.

By S. ANDREWS & S. BENSON. (Chapman & Hall). 1920. Price 15/6 net.

This book is one of the " Directly Useful " series, and as the publishers state, " occupies a midway position between purely theoretical and purely practical works." It is well and clearly written, and contains a good deal of useful information in a compact form, while the " worked out " examples will be found very useful by the student of aeronautics.

In *Chapter I.* the general principles of design are discussed, and the tables giving " weights and structural components, per centage resistances of aeroplanes, etc." will be found useful.—The " ceiling " of a machine is explained, and there is a brief discussion on stability and controlability.

Chapter II. deals chiefly with " Materials " and tables describing the principal ones in use are given—The " factor of safety " is dealt with in Table X. It should be noted that this is not the same factor of safety as that discussed on pp. 140, 141. The use of stress diagrams is clearly explained as also the " Method of Sections," which is recommended as a useful check on other systems of calculation.

In *Chapter III.* the properties of aerofoils are discussed in considerable detail. It begins with a very good description (well illustrated) of a wind tunnel and the method of using it to find the resistance of surfaces, bodies, etc.—Air data for aerofoils are next considered, and a large number of useful tables and diagrams follow. A great number of different kinds of aerofoils are examined and the effects of " gap," " decalage," " stagger," etc., are carefully gone into. The diagrams of R.A.F. wing sections No. 1 to 10 will be found useful. The Lift by Drag rates 17 in Nos. 9 and 10 is decidedly good.

In *Chapter IV.* stresses and strains in Aeroplanes are considered and much useful information regarding them is given in a handy form.

In *Chapter V.* there is a very detailed account of the " Design of Wings " commencing with a description of the different kinds of trusses used, various useful details of information such as, definition of tractor and pusher machines, the aeronautical factor of safety, etc., follow. The great importance of ascertaining the real stresses, to which a machine is subjected in the air, is pointed out, especially in the case of diving, when the mean overload may equal 12 times the weight of the machine. A good calculated example of the stresses in a certain biplane follows, and after this, the general procedure for the design of members of the wing structure is considered in detail. Useful practical examples complete the chapter.

Chapter VI. deals with " Resistances " and " stream lining." Commencing with a general description of the resistances, viz: the drag of the wings, and that due to the other parts of the machine, an explanation of " air pressure " and " skin friction " follows—The importance of making bodies, struts, etc., of fair shape is dwelt upon, and useful tables and diagrams give the resistances of such bodies in a convenient form. The usual explanation of " skin friction " is given, but there is no doubt that this subject requires a great deal of further investigation, as, up

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to the present time no satisfactory experimental method of separating "form" resistance from "frictional" resistance has as yet been discovered.

Chapter VII. contains a very good account of the methods of constructing the fuselage of a machine—Examples of different types are given (very well illustrated) and the method of finding the stresses in the members is explained. The paragraphs on the gyroscopic action of a rotary engine, and the effect of the air screw, on the fuselage should be noted.

In *Chapter VIII.* chassis are discussed and the method of calculating the forces acting on them when a machine is landing, are clearly described. The account of "shock absorbers" and the methods of designing them is particularly interesting.

In *Chapter IX.* air screws are discussed. The author considers the "Blade Element Theory" the most satisfactory one, and describes it in detail. The experimental method of design, based upon wind tunnel experiments is explained, and a calculated example, showing the application of the method to a particular air screw follows. Stresses in air screws are next considered, and some notes on construction complete the chapter.

Chapter X gives a very full account of the "stability" question, and the worked out examples will be found very useful by students.

Chapter XI.—Design of control surfaces. This is an important chapter as the subject does not always receive as much attention as it requires. Very full details are given, and the account of "construction" of control surfaces is very good.

Chapter XII. deals with "Performance" of machines, and the practical methods employed in connection with this subject. Tables LX. to LXII. will be found interesting.

In *Chapter XIII.* the process of "laying out a machine" is described, and the authors very rightly insist upon this being done in a scientific way instead of by some vague rule of thumb method.

Chapter XIV. gives an account of "the general trend of aeroplane design." A number of well known machines are described and interesting details are given in Tables LXXII. to LXXIII.

The Tables and illustrations in this book are particularly good.

J. D. FULLERTON, *Col., R.E. (ret.)*

NOTICES OF MAGAZINES.

BULLETIN BELGE DES SCIENCES MILITAIRES.

May, 1920.

(Bruxelles, Libraire Albert Dewit, Price 1 fr. 50 c.)

The first number of this monthly publication has just been issued by the Belgian Army Staff. In an introduction it is explained that as no one can honestly believe that the great struggle which has recently

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ended will be the last of all wars, and as the training of armies and the perfecting of new engines of war in peace time can only be tested on manœuvres, at military schools or in laboratories where the conditions are imaginary, this periodical has been initiated to furnish documents describing in detail both the large and the small episodes of the Great War, for the use of military students and for those whose duty it is to carry out the organization and preparation of the army. The articles in the present number cover 54 pages and include, among others, " The Operations of the Belgian Army during the Campaign of 1914–18 " (unfinished), " The Conduct of Operations by the German Grand Staff up to the Battle of the Marne " (unfinished), " The inundations on the Belgian Front." Considerable space is devoted to aviation, and brief notes are published on organization matters in the German, Dutch and British Armies.

F.E.G.S.

THE MILITÄR-WOCHENBLATT.

No. 87.—*Through a peace of slavery to Bolshevism.*—Lt. General Von Altrock declares that the treaty condemns Germany to an existence as desperate for the present as it is hopeless for the future. He says that the only thing that can prevent Germany becoming a prey to Bolshevism is permission to increase her 100,000 strong army.

A meeting was held at Charlottenburg to protest against the reckoning of private means in assessing officers' pensions and a vigorously worded resolution passed.

Officers are beginning to ask when promotion will begin again. The *M.W.B.* says there can be none just yet as things are still too unsettled and promotion at the present juncture would only lead to greater evils than it is calculated to alleviate. It hopes however that the situation will soon improve.

Roll of Honour.—Berlin police officers—24 killed.

No. 88.—*England's Military situation and the reconstruction of the Territorial Army.*—This makes the most of the difficulties now confronting England and emphasises the danger that Bolshevism is to the British Empire, all due to a peace treaty in which ignorance and hatred were the ruling factors. The Indian Army awaits the deliverance which Bolshevism will bring it, when the British troops serving in India will barely suffice to hold the important centres. Churchill insisted on an overseas obligation for the Territorial Army because he knows it will very soon be wanted.

The new defence law includes a paragraph forbidding serving soldiers to take an active part in politics. This rule has been adversely criticised in some quarters, but General Von Linden-Suden supports it as only right and proper.

General Von Zwehl, in an article on Field Marshal Joffre's leadership up to the Battle of the Marne, says Joffre was quite right to assume that Germany would violate Belgian neutrality, as the question was openly discussed in German publications and equally wrong to suppose that Germany had any intention of crossing the Dutch frontier " we never

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thought of doing such a thing!" Joffre's plan is described as a bold one, which, as it counted on irresolute leading on the part of the Germans and on good fortune, could easily lead to disaster. Von Zwehl says that it would have done so, but for the bad luck the Germans experienced on their right wing. The French success at Guise eased the situation to some degree, but it was still very critical and the deployment of the 6th Army was endangered until the Germans, already obliged to leave three Corps at Antwerp and Maubeuge, detached another two to East Prussia. This, Von Zwehl says, was a disastrous mistake. Maunoury wanted to attack the German right flank before his army was fully deployed. Joffre refused to allow this and his action is approved. Had he done so a decision would have been reached north-west of Paris, the German advance would not have penetrated so far south and the extension and the consequent weakening of the German front would have been avoided.

No. 89.—General Freytag-Loringhoven contributes a good article on the dangers of spasmodic and violent changes in national life. England, he says, owes her strength more to evolution than to revolution.

General Von Zwehl continues his remarks on Joffre's action before the Battle of the Marne. On the 1st September the French commander contemplated an extensive withdrawal of the whole of the line west of Verdun, pivoting on that point. Lord French, as we know, considered that if the English went back as far as Meaux it would be quite far enough, but Joffre indicated the line Juvizy—Melun as their position. However on the 4th September things began to look brighter for the Allies; Maunoury's Army was rapidly concentrating and word came of the German corps left at Maubeuge and Antwerp, and withdrawn from Russia. On the 5th the tables were turned. Von Zwehl comments on Joffre's good fortune in getting out of his plan to break through on the Luxembourg line so lightly. This, he calls Joffre's first great decision and declares that it was a most dangerous scheme and that if the 1st, 2nd and 3rd German Armies had only been under concerted and systematic leading, it would have resulted in disaster. It is all held to be further proof, if that were needed, that Schlieffen's project was a sound one, and, even when the French, through Italy's action, were so much stronger than had been contemplated, practically certain to succeed. Joffre's second great decision, as he characterises the formation of a shock group at Amiens, missed fire. The concentration area was too far advanced and his technical advisers should have pointed out to him the railway and entraining difficulties. This mistake however did not have very serious results. His third decision, to withdraw behind the Seine was not carried out because the offensive began, the impetus thereto being given by the voluntary withdrawal of the Germans. How the campaign would have resulted if the 2nd German Army had not started the retreat or if Joffre's plan to get behind the Seine had been carried out, opens endless problems for a strategic Kriegsspiel. Schlieffen's projects never extended beyond the frontier battle, which he thought would be decisive.

An Army Order defines the action to be taken to recover any non-public funds, such as those belonging to Canteens, Messes, Institutes, etc., which have been left behind in Poland.

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Rolls of Honour.—General Staff—a list of 65 names including Generals Von Moltke, Von Lauenstein and Von Voigts-Rhetz and Colonel Hentsch. (Is the latter he who decided on the retreat of the 1st and 2nd Armies in 1914?) Pioneer Battalion No. 27—33 Officers killed.

No. 90.—The Battle of the Marne (1914) is being increasingly examined by German students. Some appear to be more concerned with the search for a formula which shall prove that black is white and failure success, than with the elucidation of facts, but in this number General Von Trossel makes a real contribution to the history of the campaign. He commends the books of General Von Baumgarten-Crusius and Field Marshall Von Bulow as the best hitherto published but indicates several points which still want clearing up. On the 28th August orders were received from G.H.Q., for the 1st Army to advance to the Lower Seine and the 2nd Army on Paris. The 1st Army accordingly moved in a S. Westerly direction and had heavy fighting at Proyart and Framerville. Prisoners taken there disclosed the arrival, near Amiens of the 7th French Corps from Alsace. On the 30th the 2nd Army struck the 5th French Army north of La Fere and, as Von Bulow did not know that the 1st Army had strong French forces before it, he asked it for help to exploit his success. The 1st Army informed him that it was going on the 31st to advance to the Oise between Compiegne and Chauny. Von Bulow states that G.H.Q. approved of this and ordered the 2nd Army to direct its left flank on Rheims, thereby giving up the plan indicated on the 28th (1st Army to Lower Seine, 2nd on Paris). Von Trossel asks why G.H.Q. changed its mind, and how it was that it had apparently no knowledge of important detrainments near and south of Amiens, as it is not conceivable that the 1st Army failed to report them. Also how the 1st Army appreciated the situation when, on 31st August, it determined to march south on to the Compiegne—Chauny line instead of keeping its south-westerly direction, and why, knowing that there were strong even if beaten hostile forces on its right flank, there was no order given to Von der Merwitz's cavalry corps to follow them up and discover their movements if not their strength. He next discusses the G.H.Q. intentions which, as received on the night of 2nd/3rd September, were "To press the French in a S.E. direction from Paris; 1st Army in echelon to 2nd Army and to become flank guard of whole German forces," and asks how it was possible to press the enemy from Paris if the 1st Army was to follow the 2nd in echelon. Even if the 1st went forward in line with the 2nd it was impossible fully to carry out this order. He considers the first part of the order impracticable, but the second not only practicable but in accordance with the situation and quite natural as the 1st Army was the flank guard, and would have to move in echelon to fulfil its rôle as such. The ordinary way to carry it out would have been for the 1st Army to mark time and advance in succession from the left as the 2nd Army moved forward. For some reason, which Von Trossel says he cannot explain, the 1st Army, so far from dropping back, actually advanced three of its Corps and only dropped two, the IVth Res. Corps and IInd Corps as flank guard. Von Bulow declares that so far from being echeloned in rear, the 1st Army was actually echeloned in front of his Army and Von Trossel enquires why G.H.Q.

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did not interfere when they learnt that orders were not being carried out. On the 4th September, the 1st Army advanced still further. On the 5th, G.H.Q. issued new directions which were briefly, " The enemy has escaped from the encircling attack of the 1st and 2nd Armies. Reports show withdrawal of French forces from Toul-Belfort and from the front of the 3rd and 5th Armies towards the west. The plan of driving the enemy away from Paris in a S.E. direction must be given up. It is probable that he will concentrate strong forces near Paris and protect that city and threaten the German right flank. The 1st and 2nd Armies must therefore remain opposite the east front of Paris, 1st Army between Oise and Marne, 2nd between Marne and Seine in order to attack any movement from Paris." On the same day (5th September) G.H.Q. also began the formation of a new Army to strengthen the right flank. Von Trossel asks why this was not begun at the end of August. Von Bulow had ordered only a short march for the 5th September up to the line Montmirail—Vertus. On receipt of G.H.Q.'s orders he stopped the 2nd Army's forward move, merely advancing the left flank a little further up to Morains-le-Petit.

In an article on the surrender of war criminals it is asked " What will the French Army, which is alleged to be so chivalrous, think of the surrender of hundreds of our leaders who only did their duty? Will it and particularly the French Officers so far demean themselves as to agree to dishonouring their unconquered enemy, before whose sword France has trembled in hysterical terror for four years and to bringing the leaders of an Army which, even with the help of England and Russia it could not conquer, before a far from impartial tribunal? " and so on, a mixture of flattery and insults, boastings and whines, typical of a certain class of German writer.

Roll of Honour.—Bismarck Jaeger battalions (2)—62 Officers killed.

No. 91.—Von Trossel continues his remarks on the Battle of the Marne (1914)—On the 6th September the 2nd Army should have carried on its right wheel so as to form a front facing Paris, its commander assuming that the 1st Army would conform to the north of the Marne. The latter however thought it too late to hold up the moves already ordered, and also believed that, contrary to G.H.Q. orders, the pursuit should be pushed forward up to the Seine. In this respect it is important to know at what hour Lt. Col. Hentsch reached 1st A.H.Q. This could not have been before 10 or 11.0 a.m. (5th Sept.) and as the 1st Army had been on the move since 6.0 a.m. it could hardly have been possible to effect any substantial alteration in the dispositions already ordered. As G.H.Q. however knew about the forward push of the 1st Army it was essential to warn it early and a short order " 1st Army stand fast. Further orders on the way " should certainly have been sent out by wireless or telephone from far distant Luxembourg, where G.H.Q. was, in the night of 4/5th. The first part of the message from 1st to 2nd Army, that the forward movement could not be held up, appears justified. The second part to the effect that, contrary to G.H.Q.'s orders the pursuit must be pushed on to the Seine, remains obscure. Von Trossel then examines the actions which brought about the gap between the 1st and 2nd Armies and describes how it was hastily patched up by

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Kraewel's Brigade and the cavalry, who held up the British for a time, but eventually strong forces of the 5th French Army, released by the action of the 1st German Army, compelled the 2nd German Army to withdraw. Von Bulow assumes full responsibility for having so described the situation on the evening of the 8th September, to the G.H.Q. plenipotentiary Lt.-Col. Hentsch that the latter ordered the retreat. It seems to have been in consequence of these orders that the 5th German Division stopped, when, on the afternoon of the 9th September it was on the point of falling on the British left while Lord French was attacking the Kraewel Brigade at Montreuil-aux-Lions. Von Trossel speculates on the probable result if the attack, of which this was a part, had been pressed, but concludes that, though there was a big prize to be gained, the results of failure would have been disastrous to both the 1st and 2nd Armies, and that the reasons put forward by Von Bulow for his action are sound ones. We have but little information about Lt. Col. Hentsch. Von Trossel describes him as endowed with full powers, and owing to the distance and inaccessibility of G.H.Q. this must have been necessary, but it would be interesting to know more of this comparatively junior officer whose conference with Von Bulow led to one of the great decisions of the war.

Conditions of service in the National Army.—The national army will consist of volunteers who engage between the ages of 17 and 23 for 12 years' service. They must be of German birth, good character, physically fit for infantry and unmarried. After 6 years' service men will be entitled to live out of barracks. Promotion by selection after special tests. For commissioned rank, which is open to all volunteers, four years' instruction is necessary. Education for a career in civil life is given during a man's service. Officers serve to age of 45 and then on from year to year. Conditions of promotion and leave as for other ranks. Release before reaching the age of 45 can be allowed on application by an officer on the grounds of altered circumstances. He can be dismissed on account of unfitness or unsuitability. In the latter case the officer must be informed 3 months before his proposed dismissal of the reasons for it, and be allowed to appeal. Retiring pensions begin after 10 years' service. A selection board consisting of officers can pronounce the sentence of dismissal without pension "for conduct unbecoming an officer."

L. CHENEVIX-TRENCH, *Maj., R.E.*

4th May, 1920.

REVUE MILITARE GÉNÉRALE.

December, 1919.

THE ARMY BILL.

A critical examination of M. Renaudel's scheme. The title of this bill is "Projected measure for a first military contribution of France towards the covenants of the League of Nations." It states explicitly

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that this League should result in the disarmament of all nations, and in consequence that the military organisation of France should develop in accordance with international policy and with the development of the League of Nations itself. But this epoch has yet to come, and it is impossible to ask the country to abandon care for its safety and the execution of the legitimate clauses of the peace treaty. An army is therefore necessary, but should be reduced to a minimum, firstly on financial considerations, and secondly to set an example in reducing armaments. The measure rejects, in spite of the example of England and America, a regular army recruited by voluntary enlistment as "menace to democracy." Conscription, an expression of the equality of all citizens under the law, is therefore adopted, with safeguards against its assuming an aggressive character as it did before the war. This aggressive character is not inherent in the system, but, depends on the political system whose servant it is. If the government wishes it to minister to diplomatic violences and blood-thirsty designs and the vigilance of the people does not curb these desires; if the democracies cowardly surrender to such aims, and more so if they associate themselves with them to satisfy an imperialism which inevitably leads to war; if they do not insist that the instrument forged by conscription is used exclusively for the country's defence, and cannot be applied to projects of aggression, or possibly to the maintenance of distinctions of caste or class at home, then there is always danger. Democracies must always watch the development of their military administration. But such restrictions only apply to times of peace. In time of war industrial as well as military mobilization must be arranged. The above are the general considerations on which the measure is based. The following gives a clear idea of the spirit in which it was drafted "To-day it can be affirmed without fear of denial that if the nation had listened to the voices of those who counselled a defensive organization on a militia model, that is to say, if it had prepared for the methodical utilization of all its reserves, France would have victoriously resisted the blows of the enemy instead of suffering the disaster of Charleroi. Care must be taken that, as in the past, the fate of the country and of its military organization is not left in the hands of a few advisers, more or less well chosen and qualified, and of ministers more or less obliging. Democracies must not permit, in the sad and demoralizing life of the barracks, the isolation of the army or the constitution of a military caste. The army should be associated with the general life of the nation, soldiers as well as officers participating in the political and national activity of the country, and exercising all the rights of citizenship."

The characteristics of the measure are:—

Total service 28 years.
Classes called up at 20 years of age (two batches).
Practical Training 8 months.
Periods of 15 days subsidiary training—4.
No calling up of the last five classes.

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Voluntary enlistment confined exclusively to the cavalry and colonial army. Suppression of any previous deduction from the number supplied from any contingent in favour of the colonial army or of crews for the fleet.

Leave during the training service—30 days.

For the first three months the recruit is trained near his home for the last five he is drafted into a unit approximately on a war establishment, and consequently available for any kind of duty.

Batches of 100,000 each are called up every April and October. The latter will then join their war stations from January to May, and the former from July to November. The four subsidiary trainings take place in June and December, and it may be reckoned that, omitting war losses, 700,000 men will be available annually for training near their homes, and to send to their war stations 400,000 will suffice, at the rate of 100,000 for each period of 15 days' training.

The bill is at once a measure for recruiting, for army organization, and for cadres and strengths. From a strictly military standpoint the following remarks arise. It is agreed that universal disarmament may be progressively realizable, and that the strength of the Army should be in inverse ratio to that of the League of Nations, that the present strength should be the minimum compatible with security and international obligations, and also that in case of a new war the whole nation should rise against the invader. The strength can therefore be reduced considerably below that of 1914, but must not be allowed to fall below that required to train the nation in arms, and eventually to organize it for war, and cover the mobilization. From this point of view the measure shows two defects, it does not admit of the effective embodiment of a nation in arms and does not ensure the permanent security of the frontier. For a nation in arms the essential condition is the pre-existence of formed bodies sufficient in number and skill as nuclei for training, and the more rapid the mobilization the greater the number of these nuclei required. It is for consideration whether it would be better to reduce the period of service of the ordinary soldier and apply the saving thus effected to forming and training cadres, which need not be composed entirely of professional soldiers, but Renaudel's proposal tends to place obstacles in the way of the formation of such cadres. It is considered also that the number of re-engagements allowed is insufficient—it is not possible to train a N.C.O. in eight months.—(*To be continued.*)

January, 1920.

Reply to "Deductions from the World War" of Lt. Genl. von Freytag-Loringhoven.—A translation of von Freytag's article appeared in the *R.M.G.* for October, 1919. "L'Hoplite," the writer of this reply, is described as a high military official. He asks von Freytag, who accuses the French of holding feelings of hatred towards Germany,

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how he can expect it to be otherwise considering the way the latter treated them in 1870–71, and after all it is only a case of the pot calling the kettle black, and does not von Freytag's article justify the feeling? Again his explanation of the German atrocities in Belgium exceeds the bounds of impudence. He accuses the *Poilu* of having fought for France's future position in the world; he fought to escape from what he knew would be slavery. He complains of the French treatment of German prisoners, but how did the Germans treat the French civil population? He says that the beast in human shape always wakes with surprising suddenness in the French; if the German is different it is because the beast never sleeps, or only does so when one is strong enough to ensure his harmlessness. He states "We have had to do with an enemy endowed with the mental constitution of the lower orders. . . The vast difference between civilization and *kultur* is revealed." As Germany claims *kultur* for her own, France must represent civilization, but was it the French alone who were endowed with the "mental constitution of the lower orders," did they burn Louvain, lay waste Belgium and the North of France, massacre inoffensive civilians, strip houses and factories, and destroy the cathedral of Rheims? Finally, what strikes the French people in the writings of the Tirpitzs, Ludendorffs, Falkenhayns and Freytag-Loringhovens is that they never inquire if war is a wrong in itself, and an unjust war a crime. They look upon the late war as an industrial or commercial enterprise that has failed, and analyse the causes of the failure, without the slightest allusion to the terrible moral responsibility which the authors of the cataclysm have incurred.

The Army Bill.—Continued from the December 1919 number. It is argued that the arrangements for training the reserve of officers (*officiers de complement*) are absolutely inadequate, and certain facilities offered by the measure are palliatives, not remedies. Figures are given tending to show that the numbers of the annual contingents are insufficient to provide for the protection of the frontier during mobilization—including that of England and America. The numbers actually available at any time will be less than the 100,000 allowed to Germany, and there will be two periods, June and December in each year, when the only troops under arms will be the reservists doing their 15 days' training. The period of training allowed is too short for artillery, engineers, tanks, and aviation. Each chapter is criticized in detail. Chapter I. deals with recruiting. Chapter II. with training. It is noteworthy that the compulsory physical training of the youth of the nation, in order to improve the race, is provided for from 10 years of age, with preliminary military training from the age of 16. Chapter III. deals with organisation. The *Corps d'Armée* ceases to be a permanent formation. Chapter IV., Cadres and Establishments. Long service is limited, artillery and engineer staffs done away with and others reduced. Recruiting and administration to be done by civilians, all transport to be in the hands of the artillery. Alterations in the colonial forces. Higher courses in tactics, of a year's duration, to be given. Chapter V. Promotion. Chapter VI. Miscellaneous.

A. R. REYNOLDS.

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RIVISTA DI ARTIGLIERIA E GENIO.

January, 1920.

THE EMPLOYMENT OF TANKS.

It appears clearly from the recent war that tanks can be pushed forward without artillery preparation, saving enormous quantities of ammunition, without mentioning the advantage of surprise.

The tank is also of great moral benefit to the troops, saving the lives of many combatants, while carrying devastation and terror in the enemy's ranks.

Another advantage rendered possible is the reinforcing of provisions and ammunition for the troops in the first line and during the battle. Previous to the use of tanks the troops engaged were deprived of almost everything, and had to cease fighting, the roads being broken up and the railways interrupted, and when victory seemed near it could not be realized owing to the impossibility of bringing up the necessary provisions.

The employment of tanks on the largest scale, for which all the armies are now preparing, may prove an efficacious means of reinforcement, and may be the cause of a radical reform in tactics and field fortifications.

There are two kinds of tanks which may be used in battle :—heavy cars for demolitions, and light cars.

Tanks of the first type are used chiefly against strongly defended positions, which artillery fire has not succeeded in destroying or at least in sufficiently disorganizing.

The light tank (Whippet, English, and the new type Renault, French) is designed to rapidly complete the initial success of the breaking of the lines, causing confusion and panic among the enemy's troops. The French light car is especially designed to operate in strict contact with infantry.

However, to render possible the advance of the infantry, it is necessary that all the enemy's machine guns should be silenced, and as the zone of action of the tanks becomes at once, after their entry into the lists, a zone of concentration for the enemy's fire, it is indispensable, as has been clearly shown from the experience of war, that the assaulting tanks should always be used in mass, and never isolated or in small groups ; and on the other hand it is necessary that the accompanying infantry should be numerous.

It is important that there should be a distribution in depth of the assaulting tanks so that the infantry reserves should correspond with like reserves of tanks.

It is also necessary to take into account that during the battle many cars will be disabled by damage to the motors, or by the fire of the enemy's artillery.

In order to diminish as far as possible the losses, and to profit by surprise, the tanks should enter into action at dawn or at a time of mist or fog.

In cases of serious resistance the tanks should attack frontally, while the infantry manœuvre on the flanks. On gaining the established objective the cars should be ready to continue the action by guarding the ground to the front against eventual counter-attacks.

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The preliminary operations previous to action are:—

(*a*) Reconnaissances in order to inform the command on the possibility of employing the assaulting cars on the ground to be traversed, and for establishing posts for assembling, waiting, and starting.

(*b*) Local reconnaissances to give to every unit the precise idea of the development of action, exploring the roads and the obligatory routes, and for determining the works required to be executed for the passage of the tanks across our lines, and studying minutely the organization of the enemy's defences. After establishing the data for action the tanks should be transported by railway or by ordinary roads, as near as possible to the scene of action, and afterwards to the position of departure, where they should arrive at least two hours before the commencement of the attack. All the movements should be made at night or in misty weather.

If the action is preceded by artillery fire of long duration, the tanks may be usefully employed against the enemy's second line, as it may be presumed that the first line has been completely destroyed.

If the attack is undertaken by surprise and always at dawn a short but violent fire on the enemy's lines should be required from the artillery. The fire should be transformed into a movable barrage, with an increase of range of 100 metres to the minute, and with a proportion of smoke shells, so as to create a smoke barrier between the tanks and the enemy. Field guns can eventually follow the attack in order to neutralize the enemy's artillery of small calibre in anti-tank positions. The infantry advancing in strict contact with the cars should protect them at all costs.

Aeroplanes flying low, besides deadening by their motors the noise of the tanks, should harass the enemy with smoke shells, attacking the batteries from time to time and furnishing information to the crews of the tanks on the general progress of the battle.

To give an idea of the organization of the assault we may quote the system established in the French army and which was adopted by other armies.

In France usually previous to an action there was assigned to each infantry division a battalion of assaulting tanks of three companies with three sections each.

The unit for manœuvres and the tactical unit was the section, composed of five cars (one command-car and two half sections—composed each of a cannon-car—and of two mitrailleuse-cars, whose duties were to work on the flanks and to co-ordinate their efforts according to the orders of the commandant of the section). The formations for battle are lines and columns.

The commandant of the section gives his orders by means of flags waved from the cupola of his tank.

The various means for communication are scrupulously attended to: they are essentially pigeons and small courier-cars equipped with wireless apparatus (one for each company).

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It is evident from what has been said that every operation of war depends on the assistance of the accompanying infantry on whom depend the solution of the combat.

Every attack by combined tanks and infantry requires long and methodical preparation.

ANTI-TANK DEFENCES.

There are several methods of defence against tanks, the chief one being the posting of artillery of small calibre at short distances from the first lines so as to fire against them.

If isolated pieces of 37 to 50 mm. are employed in certain sectors, each field battery selects an advanced position for one piece, from which it can contest the probable passage of the enemy's assaulting tanks.

Besides shell fire it also may be useful to arrange for protection by means of smoke and asphyxiating gas, which would compel the crews of the cars to wear masks and thus harass the movements of their machines.

Infantry and machine guns are also supplied with small perforating bullets to fire against the armour of the assaulting cars. The ground over which the assaulting tanks have to pass should be mined. Deep pits may be dug covered with thin strata of earth in the vicinity of the more important centres of resistance, and near to which isolated quick-firing guns are placed so as to fire directly at short distances on the enemy's tanks, when the latter owing to having fallen into these pitfalls are put out of action and present easy targets.

SPECIAL USE FOR TANKS.

Tanks may be used in savage warfare, and in fact were used in Lybia, and would have been more largely used if the Arabs had not surrendered without fighting.

It can also be foreseen that they may be largely used and with good results, for public security, in repressing riots, a use for which they are far better adapted than unarmoured cars.

E. T. THACKERAY.

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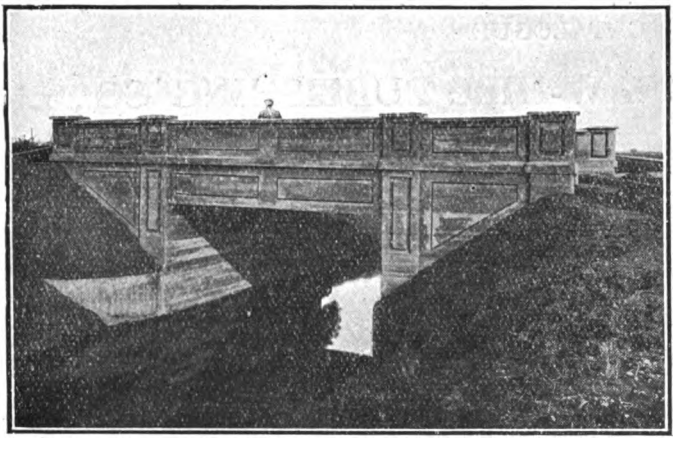

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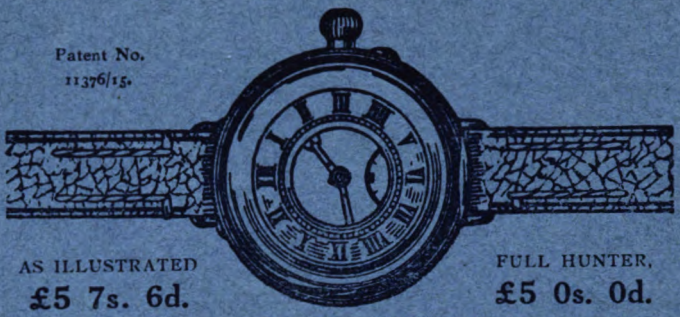

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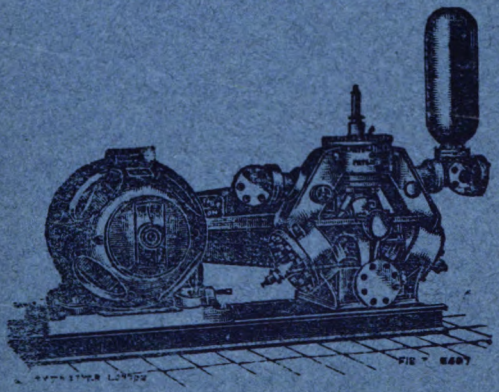

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